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BULLETIN No. 8.

DEPARTMENT OF AGRICULTURE

—OF—

BRITISH COLUMBIA.

FEEDING FARM ANIMALS, PRINCIPALLY IN REFERENCE TO DAIRY COWS.

FEEDING FARM ANIMALS, AND PRINCIPALLY IN REFERENCE TO DAIRY COWS.

In response to requests made at various times, and in conformity with promises made, I now beg to present this Bulletin for the guidance of those who are desirous of feeding in a more scientific, economical and profitable manner.

It must not be supposed, however, that the results given in the following pages are the lucubrations of my own brain, or the result of my own experience, further than a careful study of the authorities at my command. I have endeavoured, without going too deeply into the scientific aspect of the question, to place before my readers as succinctly as possible the feeding values of the foods which are generally produced in the Province, or which can be purchased profitably, descriptions of various foods, rations for farm animals, compounding rations, feeding standards, effect of feed, care of dairy cows, frequency of feeding and various rations as fed in the United States and Canada. The last will serve as a guide in compounding rations, and will, I believe, be a great help.

I quote largely from a bulletin on stock feeding by Prof. W. J. Spillman, of the Agricultural College of the State of Washington. The similarity of conditions in that State to those existing in this Province makes the results given in that bulletin of particular value to our farmers, and I, therefore, commend the quotations from that source to their particular attention. A book entitled "Feeds and Feeding," by Prof. W. A. Henry, of the Agricultural College of the State of Wisconsin, a work of world-wide fame, is also largely quoted from. From the Ontario Bulletin No. 104, entitled "Rations for Dairy Cows," I quote a number of rations, with comments thereon. Lastly, Wisconsin Bulletin No. 33, "Rations for Dairy Cows," is quoted from in relation to rations for dairy cows.

With the sincere hope that the contents of the present bulletin may be of real benefit to the dairymen and farmers generally of British Columbia,

I remain most faithfully,

J. R. Anderson,
Deputy Minister of Agriculture.

Department of Agriculture,
Victoria, May 21st, 1901.

The following is from Bulletin 43, Washington Agricultural College, by Prof. W. J. Spillman:—

"CONSIDERATIONS IN COMPOUNDING RATIONS.

"*Amount.* In determining the amount of feed an animal ought to have, a number of things must be taken into consideration. Regard must be had with reference to what the animal is to do with its food.

"Let us first consider the case of a mature animal which is neither being fattened for the market, giving milk, producing wool, or doing work of any kind. Such an animal needs food only to supply the heat of the body, the small amount of energy required for the necessary activities of the body, and to repair the small waste of body material going on at all times. Such an animal would naturally need very little protein, and not a large quantity of carbohydrates and fat; and the amount of food required would depend almost entirely on the size of the animal. Under such conditions an 800-pound animal would need half as much food as one weighing 1,600 pounds.

"A ration intended for animals under the condition just described is called a maintenance ration. It is supposed to maintain a mature, idle animal in substantially its present condition, when neither growth, increase of fat, milk, wool or work is required of it.

"Suppose now that the animal in question is a young, rapidly growing one. This animal should have, in addition to its maintenance ration, enough to supply the heavy demand for materials with which to make new body material. Such an animal should not only have more food than a mature, idle animal of the same size, but that food should have a larger proportion of protein in it, because it is protein which builds up the tissues. The activities of a young animal are also usually greater than those of older animals, and the body temperature slightly higher. Hence they need slightly more carbohydrates and fat than older animals in proportion to their weight.

"In the case of animals that are expected to lay on fat it is plain that they should have large amounts of carbohydrates and fat, in addition to their maintenance ration. But since fat animals that have large proportions of lean meat amongst the fat are much more desirable for meat-making purposes than those that are simply a ball of fat, and since an animal that is to continue a long, rapid growth must develop large, strong bones to carry its heavy carcass, it is also plain that fattening animals should have liberal supplies of protein, especially in the earlier part of the fattening period, when growth of frame is so desirable. It is only during the finishing up period that the amounts of carbohydrates and fat should run considerably ahead of the already large supply of protein.

"In the case of cows giving milk, it should be remembered that the casein and albumen of milk are made from protein; while the butter fat and milk sugar are made from carbohydrates and fat. It is plain, therefore, that a milk cow needs, in addition to her maintenance ration, a quantity of protein, carbohydrates and fat proportionate to the amount of casein, albumen, fat and sugar she is producing. In fact the production of milk actually takes these materials from the blood; and if the supply furnished in the food is not enough to supply the demands of the body, and furnish materials for milk-making, the tissues are robbed of their regular maintenance supply. Under such circumstances cows not only lose their fat, but their muscles, etc., are gradually reduced in weight. The writer has seen cows that have almost "milked themselves to death," because of the long established habit of making milk instead of meat out of what they ate. The ideal dairy cow is one that consumes large quantities of food and uses it all in making milk, except just enough to keep the body in good, thrifty condition.

"The same remarks apply to sheep growing a heavy fleece of wool as to cows giving milk. The feed should be sufficient to supply the needs of the body, and to furnish material out of which the wool is made. Wool, like bone and muscle, requires large quantities of protein in its production.

"One other class of animals remains to be considered, namely, those doing work. It has already been stated that part of the protein is burned in the blood before it gets to the tissues. When an animal is at work much more of the protein is thus burned; hence, in order to insure that the tissues will get their share, we must feed more protein. But the energy for work is not all furnished by burning protein, or at least need not be if we will feed an abundance of carbohydrates and fat. Hence we feed a working animal more of all kinds of nutrients.

"The amount of food given an animal, then, should be governed by the size of the animal, and by what is required of it in the way of growth, work, wool or milk production. But since the work an animal can do is largely determined by its size, and the amount of growth, and wool or milk production depends a great deal upon size, we see that for animals under the same conditions as to age, work, etc., the size is after all the most important factor in determining the quantity of its food. In exceptional cases, as in the case of a small cow giving an unusual quantity of rich milk, exceptions must also be made in the amount fed.

"To sum up the whole thing in a practical way, we may say that every animal should be fed all the protein, carbohydrates and fat that it can make profitable use of. Hence, to get the best results, brains are as necessary in the feeder as protein, etc., are in the feed.

"*Bulk of the Food.* Another consideration that must govern us in making rations for stock is the bulk of the feed. With such bulky feed as wheat straw, even if it were highly palatable, a horse could hardly eat enough at three feeds to supply the needed ingredients for a hard day's work.

"With ordinary hays and grains it has been found desirable to allow about one-third of the dry matter of the feed of a cow to be of grain, and the other two-thirds hay. This ordinarily gives sufficient nutriment, along with sufficient bulk, to insure proper response on the part of the digestive organs. About the same proportions are suitable also for horses at work. While with idle horses and dry cows, less grain, or none at all, should be fed, so that the bulk of the food may still be maintained, although the quantity of nutriment in it is lessened. In general, any concentrated feed should be fed along with some bulk feed.

"*Palatability.* We must also have due regard to the palatability of food. If a cow, for instance, be fed only one or two things, and this same ration is fed for a long time with no variation, she is very liable to grow so tired of it that she will not eat enough. It is not wise to feed any ration continuously for many months, no matter how nearly balanced it may seem to be. We should, to a certain extent, allow stock to select their feed, by noticing what they eat most readily. In that way a cow may be able to tell you that her ration is not quite satisfactory, though the books say it ought to be.

"We may also, by properly combining feeding stuffs, be able to feed a considerable amount of dry, unpalatable straw and the like, to advantage. The unpalatability of the straw is largely due to the small amount of nutriment it contains, but when fed with some hay, like alfalfa, that is comparatively rich, the evils of the one tend to correct those of the other, and the mixture becomes more palatable than either, alone.

"We may often increase the palatability of dry feeds by having silage or roots to feed with them. We may, perhaps, make the general assertion that when two feeds are faulty in opposite directions, one having too much protein, for instance, and the other having too much carbohydrates, they will be eaten more readily when fed together, or on the same day, than when each is fed alone for several days.

"*Changing Feed.* A very important matter is the changing from one ration to another. An incident that occurred in our college herd well illustrates this. The regular herdsman was called away for some unavoidable reason, and his place was taken temporarily by another who was not familiar with the feeds at his command. It happened that the introduction of silage into the feed of the milk cows had just begun when the change of herdsmen took place. Directions had been given to give each cow five pounds of silage a day at first, and to increase this not more than five pounds per day at any one time till the cattle had become used to it. In a few days the cattle had become so fond of the silage that the new herdsman, through a sense of kindness, increased the feed from 10 to 25 pounds in one day. Two days later our most valuable cow died from peritonitis, which the State Veterinarian, Dr. S. B. Nelson, said was due to the sudden increase in the amount of silage fed.

"Enough has been said to impress the importance of going slow in making any radical change in the feed of any animal. Calves may gradually be changed from fresh whole milk to sour skim milk, provided it is done by an experienced hand, but a reckless hand would probably kill the calf, or sadly impair its usefulness, in making this change.

"*Cooking.* It has been demonstrated in numerous careful experiments that cooking grain of any kind for hogs, is not only a waste of time and labour, but that it actually causes a decrease in the amount of pork produced from a given amount of grain. Whether it would pay to cook grain for cattle and horses the writer does not know; but as far as hogs are concerned it is a positive detriment. The protein especially of the grain seems to be rendered to a certain extent less digestible by the process of cooking.

"In the case of root crops, especially potatoes, when fed to hogs, they should be cooked. The cooking does not add to digestibility here, but it adds to palatability; so that hogs will eat more cooked potatoes than they will of raw. And since it is the amount eaten over and above a maintenance ration that produces all the gain, we can see the importancce of feeding a growing hog all it can eat.

"The question often arises whether it pays to steam hay for cattle. Definite information on this question is not at hand; but in the case of coarse, unpalatable stems, it is probable that steaming would cause cattle to eat them more readily, and thus prove beneficial.

"*Effect on Milk and Butter.* There are a number of feeding stuffs that have a decided influence on the milk and butter produced. In feeding dairy cows, care should be taken when feeding substances known to taint the milk, to feed such materials immediately after milking, and at least ten hours before the next milking. Turnips may be thus fed without injury to the milk.

"In feeding raw potatoes do not feed a dairy cow more than 20 or 25 pounds a day. A larger quantity produces a peculiar effect on the butter.

"Carrots are reputed to give butter a yellow colour. The writer has no positive knowledge as to the truth of the matter.

"Experiments indicate that linseed meal and gluten meal tend to render the butter product less firm, while cotton seed meal, oats and sugar-beet pulp give a firm butter. Oats also tend to give a higher colour to butter, while cotton seed meal makes it paler, and raises its melting point several degrees.

"*Digestibility.* A simple chemical analysis, showing the amount of protein, carbohydrates and fat in a given feed, does not tell us what its value as a feeding stuff is. The reason is, that animals can digest only a portion of the nutritive elements in food. Hence, in order to know the amount of really useful materials in a food it is necessary to analyze a sample of the food, then feed it to an animal and carefully collect and analyze the manure produced, so as to know what the animal really got out of the food. For example: Let us suppose that a dry cow is fed 20 pounds of timothy hay per day. Analysis shows that 20 pounds of timothy hay cut in full bloom contains the following:—

	Protein.	Carbohydrates.	Fat.
20 lbs. timothy hay -------------	1.2 lbs.	14.3 lbs.	.6 lbs.

"Now, by carefully analysing the manure produced, and deducting the amounts of protein, etc., found in it from the amounts fed, we should find the digestible nutrients in 20 pounds of timothy hay to be about as follows:—

"Digestible nutrients in 20 pounds timothy hay: Protein, 0.57 pounds; carbohydrates, 8.72 pounds; fat, 0.29 pounds; 0.57 pounds is 48 per cent. of 1.2 pounds; *i. e.*, the protein in timothy hay is 48 per cent. digestible. In the same way the digestibility of the carbohydrates is found to be 61 per cent., and of the fat, 48 per cent.

FEEDING STANDARDS.

"We have learned that different animals, and even the same animal under different conditions, require different amounts of protein, carbohydrates and fat in their daily rations. A great deal of experimental work has been done to determine just how much of these constituents are needed by animals, and most valuable results have been obtained. Most of this work has been done in Europe, but a great deal of it is now being done at American experiment stations, especially in the case of milk cows. Feeding standards are simply the rations recommended by investigators in this line. It should not be supposed that the standards given below are absolutely perfect for all times and places. Future investigations will undoubtedly modify them more or less. When considering the compounding of standard, or balanced, rations, we shall see how, under certain circumstances, we may be justified in departing from these standards.

"Since there has been more investigation regarding standard rations for milk cows than for any other class of animals, we will give this subject more particular attention. Dr. Emil Wolff, the eminent German investigator, after many years of study and experiment, has concluded that a cow weighing 1,000 pounds and giving a full flow of milk, will do her best work when her daily feed furnishes digestible nutrients as follows:—

"Protein, 2.5 lbs.; carbohydrates, 12.5 lbs.; fat, .4 lbs.

"American investigators pretty generally agree that the amount of fat in this ration is not quite as much as it should be. Woods and Phelps, of Connecticut, recommend the following:

"Protein, 2.5 lbs.; carbohydrates, 12.5 lbs.; fat, .65 lbs.

"Perhaps the most valuable investigations on this subject in this country are those of Prof. F. W. Woll, of the Wisconsin experiment station. By corresponding with more than one hundred of the most successful dairy farmers of the United States, he learned that the average amount of protein, carbohydrates and fat fed by these men is about as follows:

"Protein, 2.2 lbs.; carbohydrates, 13.3 lbs.; fat, .7 lbs.

"This may be said to represent the average of successful practice in this country. We cannot deny that these same men might be still more successful if they had fed more protein and less carbohydrates and fat, but of this we are not certain. In compounding rations, I usually feel satisfied with a ration that contains from 2.2 to 2.5 lbs. protein, 12.5 to 13.3 lbs. carbohydrates, and .4 to .7 lbs. fat.

"For a dry cow weighing 1,000 pounds, when it is desired to keep her in about her present condition, Dr. Wolff recommends the following ration:—

"Protein, .7 lbs.; carbohydrates, 8.0 lbs.; fat, .15 lbs.

"This is called a maintenance ration.

"Collecting these standards together for the sake of comparison, and combining the carbohydrates and fat, we have:—

FEEDING STANDARD FOR DAIRY COWS.

	Dry matter.	Protein.	Carbohydrates and Fat.	Nutritive Ratio.
Maintenance ration	17.5	.7	8.3	11.9
Wolff's standard	24.0	2.5	13.4	5.4
Woods & Phelps' standard	25.0	2.5	14.0	5.6
Woll's standard	24.5	2.2	14.9	6.8

"PROTEIN AND MILK YIELD.

"In order to keep the tissues of the body in proper repair, a thousand-pound cow requires about .7 lbs. of protein daily. The amount she must have in addition to this depends on the amount of milk she gives. Milk, on the average, contains 3.6 per cent. of nitrogenous material. If a pound of protein absorbed into the blood could be converted into a pound of casein and albumen, the nitrogenous constituents of milk, then a cow would require 3.6 lbs. of digestible protein in her feed for each hundred pounds of milk she gives, in addition to the .7 lbs. daily required by the tissues of the body. But, as before stated, when the blood contains considerable digested protein, a good deal of the protein is burned before it can be appropriated by the milk glands; so that it is not surprising to learn that both the experience of feeders and the results of experiments at the stations indicate that we should feed considerably more protein than would suffice if there were no loss by burning. The following table will make these statements clearer:—

"PROTEIN FOR COWS.

Daily yield of Milk.	Protein required for Casein & Albumen in the Milk.	Protein required by body tissues.	Total of last two columns.	Estimated surplus lost by burning.	Total Protein in Ration.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5	.18	.70	.88	.88	1.06
10	.36	.70	1.06	.36	1.42
15	.54	.70	1.24	.52	1.76
20	.72	.70	1.42	.66	2.08
25	.90	.70	1.60	.78	2.38
30	1.08	.70	1.78	.88	2.66
40	1.44	.70	2.14	.96	3.10
50	1.80	.70	2.50	1.02	3.52
60	2.16	.70	2.86	1.06	3.92

"Concerning this table, it may be said that the fourth column shows the amount of protein certainly needed, even if there were no loss by burning. That there is such loss is practically certain, but just how much we do not yet know. The estimate given in next to the last column of the table is probably not far wrong. The last column shows what is probably the smallest amount of digestible protein it is wise to feed a cow, giving the amount of milk set opposite in the first column. There is no particular objection to feeding more than this (to cows) if protein is cheap. If we feed less, one of two things must happen: If her body continues to appropriate the protein it needs, she will fall off in milk; if she keeps up her milk flow, her body will not be properly nourished, and she will lose flesh.

"This table and the accompanying discussion is given not so much to show the right amount of protein to feed a cow, but to show why it is so necessary to give enough of this important element. Nearly all writers on such topics recommend more protein than this table shows, and they are probably wise in so doing.

"The table below gives the rations recommended by Wolff for different animals under different conditions of growth, activity, etc.:—

"TABLE OF WOLFF'S FEEDING STANDARDS.

"Amount of digestible nutrients an animal should have per day for each 1,000 lbs. of live weight.

Animals.	Protein	Carbohydrates and fat.	Nutritive Ratio.
	lbs.	lbs.	lbs.
Cattle—			
Milk cows, in full flow	2.5	13.4	5.4
Oxen or cows standing idle	.7	8.3	11.8
Oxen moderately worked	1.6	12.0	7.5
Oxen heavily worked	2.4	14.3	6.0
Fattening steers—First period	2.5	16.1	6.5
Second period	3.0	16.5	5.5
Third period	2.7	16.2	6.0
Growing cattle—2-3 months old	4.0	18.5	4.6
3-6 months old	3.3	15.5	4.8
6-12 months old	2.6	15.0	5.8
12-18 months old	2.0	13.9	7.0
18-24 months old	1.64	12.8	7.0
Horses—			
Moderately worked	1.8	12.6	7.0
Heavily worked	2.8	15.2	5.4
Sheep—			
Coarse-woolled breeds	1.2	10.8	9.0
Fine-woolled breeds	1.5	11.8	8.0
Fattening sheep—First period	3.0	16.3	5.4
Second period	3.5	15.8	4.5
Growing lambs—5-6 months old	3.21	17.3	5.4
6-8 months old	2.54	14.0	5.6
8-11 months old	2.13	12.4	5.8
11-15 months old	1.71	11.7	6.9
15-20 months old	1.42	11.0	7.7
Swine—			
Fattening hogs—First period	5.0	27.5	5.5
Second period	4.0	24.0	6.0
Third period	2.7	17.5	6.5
Growing fat swine—2-3 months old	7.6	30.0	3.9
3-5 months old	5.0	25.0	5.0
5-6 months old	4.3	23.7	5.5
6-8 months old	3.4	20.4	6.5
8-12 months old	2.5	16.2	6.5

" It should be carefully kept in mind that the above rations are for 1,000-pound animals in every case. A pig weighing only 100 pounds should have one-tenth of the ration given in this table for a pig of its age. An ox weighing 1,500 pounds should have one and five-tenths times the ration for oxen given in the table, and so on. The reason for giving the rations all referred to 1,000 pound animals is that we are thus enabled to make legitimate comparisons between the rations. Look, for instance, at the enormous amount of both flesh-forming and heat and energy-producing nutrients fed to hogs campared to other animals of the same size. Hogs grow more rapidly than any other class of farm animals; they also produce this growth more economically than any other. The amount they can digest over and above their maintenance ration is very great, and as this excess is what produces growth, they make most rapid growth. The farmers of the United States have made more money from hogs than from either cattle, sheep, or horses. Compare again the amount of protein fed to young animals and that fed to older animals. The table does not mean that the amount of protein, for instance, fed to calves two or three months old is twice as much as that fed to calves twelve to eighteen months old, but it does mean that, according to their weight, they are fed twice as much.

" USE OF THE TABLE.

" The table giving the digestible nutrients in one pound of the various feeding stuffs is made use of as follows:—Suppose it is desired to find the digestible nutrients in 7 lbs. of barley. By referring to the table we find that one pound of barley contains .087 lb. protein, and .682 lb. fuel. Seven pounds would contain, then, seven times these quantities, or

Protein=.087×7=.609 lb.
Fuel=.682×7=4.774 lb.

" With a little practice this operation can be performed mentally, only the products being set down.

" COMPOUNDING RATIONS.

" Having learned something of the requirements of the animal body in the way of food, and of the nutritive content of the various feeding stuffs, let us now consider the method by which we may secure balanced rations for our stock. As the problem is much simpler where few kinds of material are fed, we will take up first the feeding stuffs available in the central part of the State, where many animals are fed solely on alfalfa. Since the principles involved in compounding rations are the same for all classes of animals, we will take, to illustrate the method, the case of a thousand-pound cow giving, say, 25 lbs. of milk a day. Such an animal, according to the table of feeding standards above, needs daily from 2.2 to 2.5 lbs. of protein, and 13.4 to 14.9 lbs. of fuel, (carbohydrates and fat). If she eats 30 lbs. of alfalfa hay a day she gets the following quantities of nutriment:

"30 lbs. alfalfa hay=3.24 lbs. protein, and 12.72 lbs. fuel.

" The total amount of nutriment is just about right, but there is considerably more protein than is necessary. This is not particularly objectionable, however, in the case of cows. Neither is the amount of dry matter (26.7

lbs.) in 30 lbs. of alfalfa hay much higher than is usually fed (25 lbs.) It should also be remarked that if this ration were unbalanced the other way, that is, if it were low in protein and high in fuel, it would be a serious fault, because the fuel materials can not be used for repairing the body or for making casein and albumen of milk. On the other hand, the excess of protein in the above ration is burned as fuel, and takes the place of the shortage in carbohydrates and fat.

"There is a very important reason, however, why the above ration is not an ideal one. Any farm animal kept on a single feed tends to grow tired of it, and if the feed is unbalanced, this tendency is greater. Hence it is not probable that such a cow as that we are considering, would eat 30 lbs. a day of alfalfa for any length of time. Farmers in Central Washington have frequently told the writer that stock fed exclusively on alfalfa hay will eat greedily almost any kind of coarse feed, such as straw, dried grass, etc. This is because their ration has grown more or less distasteful to them. It is very probable, therefore, that if such a cow were given somewhat less alfalfa hay and some other feed richer in carbohydrates and fat, she would eat more, and hence give more milk. In feeding milk cows, work horses, and young, growing stock, it is very important to have them eat an abundance of food; hence, unless the carbonaceous feeds were too high-priced, it would probably pay to feed something like corn, barley, or wheat with alfalfa hay in the case we are considering. Let us see what effect such an admixture would have on this ration. A pound of alfalfa hay contains .532 lbs. of digestible nutrients, while a pound of wheat contains .832 lbs.; hence a pound of wheat will take the place of about 1½ lbs. of the hay.

"Let us therefore substitute 8 lbs. of wheat for 12 lbs. of hay. We then have:

1.

	Protein. lbs.	Fuel. lbs.
18 lbs. alfalfa hay	1.94	7.63
8 lbs. wheat	.82	5.84
	2.76	13.47

"This is still a little rich in protein, but is not a bad ration. Whether it would pay to feed the wheat (or barley or corn), would depend on the cost of the grain, and upon the increase of appetite which it might give the cow.

"We shall now arrange a number of rations with alfalfa hay as a basis to show the effect of feeding various things with this substance:

2.

15 lbs. alfalfa hay	1.64	6.40
10 lbs. wheat	1.02	7.30
	2.66	13.70

3.

13 lbs. alfalfa hay	1.40	5.54
11 lbs. wheat	1.12	8.04
	2.52	13.58

4.

	Protein.	Fuel.
20 ℔s. alfalfa hay	2.16	8.52
7 ℔s. barley	.61	4.77
	2.77	13.29

5.

	Protein.	Fuel.
18 ℔s. alfalfa hay	1.94	7.63
8 ℔s. barley	.69	5.46
	2.63	13.09

6.

	Protein.	Fuel.
15 ℔s. alfalfa hay	1.64	6.40
10 ℔s. barley	.87	6.82
	2.51	13.22

7.

	Protein.	Fuel.
20 ℔s. alfalfa hay	2.16	8.52
6 ℔s. corn	.47	4.57
	2.63	13.09

8.

	Protein.	Fuel.
18 ℔s. alfalfa hay	1.94	7.63
8 ℔s. corn	.63	6.10
	2.57	13.73

9.

	Protein.	Fuel.
17 ℔s. alfalfa hay	1.84	7.21
8 ℔s. corn	.63	6.10
	2.47	13.31

10.

	Protein.	Fuel.
20 ℔s. alfalfa hay	2.16	8.52
40 ℔s. mangels	.40	2.68
	2.56	11.20

“This ration is much too low in fuel.

11.

	Protein.	Fuel.
20 ℔s. alfalfa hay	2.16	8.52
60 ℔s. mangels	.60	4.02
	2.76	12.54

“Still too low in fuel; most cows would not eat so many mangels.

12.

	Protein.	Fuel.
25 ℔s. alfalfa hay	2.70	10.60
25 ℔s. mangels	.25	1.68
	2.95	12.28

“This ration contains about half a pound of protein above what is needed, and lacks about a pound of fuel. It is not so good a ration as the next.

13.

	Protein.	Fuel.
25 lbs. alfalfa hay	2.70	10.60
25 lbs. carrots	.27	2.20
	2.97	12.80

" Here the excess of protein just about makes up for the lack of fuel, and this ration ought to be fairly satisfactory.

14.

	Protein.	Fuel.
25 lbs. alfalfa hay	2.70	10.60
15 lbs. potatoes	.21	2.50
	2.91	13.10

" This ration is satisfactory as far as the amount of nutriment is concerned. Potatoes, however, sometimes have a bad effect on butter, especially when 20 or more pounds a day are fed. They are said to cause cream to be difficult to churn, to make the butter soft, and to impart a peculiar taste to the butter.

15.

	Protein.	Fuel.
20 lbs. alfalfa hay	2.16	8.52
45 lbs. sugar beet	.49	4.68
	2.65	13.20

" This will give abundant nutriment of the right sort if the cows would eat so many beets, and some cows would do so.

16.

	Protein.	Fuel.
20 lbs. alfalfa hay	2.16	8.52
35 lbs. corn silage	.32	4.73
	2.48	13.25

" No. 16 ought to be satisfactory.

17.

	Protein.	Fuel.
20 lbs. alfalfa hay	2.16	8.52
60 lbs. sugar beet pulp, wet	.60	4.62
	2.76	13.14

" A good ration if the cow would eat so much pulp, and some would do so readily.

18.

	Protein.	Fuel.
20 lbs. alfalfa hay	2.16	8.52
10 lbs. barley straw	.14	4.44
	2.30	12.96

" The ration is a little short in both protein and fuel, but cows would probably not eat so much of such feed. It could not, therefore, be a very satisfactory ration.

" Alfalfa is indeed a wonderful plant. All the rules for compounding rations have been worked out in sections where alfalfa was nearly unknown.

The remarkable thing about it is that it is so rich in protein. This enables us to get balanced rations from this hay combined with roots alone, or with silage, or even with straw, in which latter case, however, the ration barely contains enough nutriment. This means that in winter, with cows in full flow of milk, we can feed them in some parts of the State for 6 to 8 cents per head per day.

"It should be remembered that cattle that have never eaten alfalfa do not like it readily; hence those dairymen in the cities who buy alfalfa hay should go slow and feel their way carefully before feeding any of the rations outlined above. For a change from such rations, which would probably grow monotonous after a time, the following would answer:

	Protein.	Fuel.
16 lbs. alfalfa hay	1.73	6.78
25 lbs. carrots	.27	2.20
7 lbs. barley	.61	4.77
	2.61	13.75

"WEST SIDE RATIONS.

"The principal feeding stuffs grown in Western Washington are timothy, clover (red and alsike), pease and oats, roots, clover and pea silage, and oats. Those purchasable at reasonable prices are alfalfa hay, bran, shorts, and various bye products, such as brewers' grains, oil meal, etc., though the last named is usually sold at so high a price that farmers can not afford to feed it extensively. Nearly the same list of feeding stuffs apply to the Kittitas Valley, one of our best developed dairy sections.

"It is not difficult to secure ideal rations from the above list; but unless we use pease and oats in some form, there is some difficulty in securing enough protein in the rations without buying the expensive concentrated feeds. The greater variety of feeding stuffs available on the west side undoubtedly renders the rations more palatable on the whole than those where only a few materials are to be had, other things, of course, being equal.

"Below are found a few west side rations which illustrate a few of the types which are commonly fed, or which may easily be fed. It will be noticed that where pease and oats are used, either as hay or silage, that much less grain is required to make a satisfactory ration. The figures used for the composition of pease and oats are those for this feed when cut at the stage when the earliest pease are large enough for table use, and the oats are about mature, but not yet turning yellow.

1.

	Protein. lbs.	Fuel. lbs.
8 lbs. timothy hay	.23	3.55
8 lbs. clover hay	.65	3.50
30 lbs. mangels	.30	2.01
4 lbs. bran	.50	2.02
4 lbs. shorts	.43	2.59
	2.11	13.67

"Substituting 30 lbs. carrots for the mangels in this ration, we have pro. 2.14, fuel 14.27, which is a very fair ration. If we use turnips instead, it gives pro. 2.11 lbs., fuel 13.94 lbs., which is also a very good ration.

2.

	Protein.	Fuel.
6 lbs. timothy hay	.17	2.66
6 lbs. clover hay	.49	2.63
45 lbs. mangels	.45	3.55
10 lbs. oats	.93	5.77
	2.04	14.61

3.

16 lbs. pea and oat hay	1.55	6.56
45 lbs. mangels	.45	3.35
2 lbs. bran	.25	1.01
4 lbs. shorts	.43	2.59
	2.68	13.51

4.

8 lbs. timothy hay	.23	3.55
8 lbs. alsike hay	.63	3.52
32 lbs. pea and oat silage	1.09	5.06
4 lbs. barley	.34	2.76
	2.29	14.89

5.

15 lbs. pea and oat hay	1.46	6.30
32 lbs. clover silage	.89	4.89
4 lbs. shorts	.43	2.59
	2.78	13.78

"PALOUSE COUNTY RATIONS.

"In most parts of the great grain-growing section of Eastern Washington there is not enough rainfall to make clover a successful crop, and no satisfactory substitute has yet been found for it, unless it is pease. Alfalfa does well enough to pay to grow it, but it is not adapted to rotation farming as clover is, having an enormous root system which makes it difficult to plow the sod.

"The following rations exhibit some of the difficulties that confront the dairymen in the wheat section, especially the difficulty of getting enough protein:

1.

	Protein. lbs.	Fuel. lbs.
20 lbs. wheat hay	.68	9.64
10 lbs. bran	1.26	5.06
	1.94	14.70

"The amount of dry matter (27.1 lbs.) in this ration is rather high, and cows would not long continue to eat enough of it.

2.

	Protein.	Fuel.
15 lbs. wheat hay	.51	7.23
30 lbs. carrots	.33	2.64
10 lbs. bran	1.26	5.06
	2.10	14.93

“No. 2 is a fairly satisfactory ration to feed during a part of the time.

3.

	Protein.	Fuel.
7 lbs. oat hay	.29	3.27
7 lbs. wheat hay	.23	3.37
25 lbs. corn silage	.22	3.38
4 lbs. pease	.80	2.25
4 lbs rolled wheat	.41	2.92
	1.95	15.09

“It will be noticed that the protein in this ration is too low, although 4lbs. of pease, which are very rich in protein, are fed. On the other hand, see how easy it is to get good rations by using a good quality of pea and oat hay, as in the next two rations.

4.

	Protein.	Fuel.
13 lbs. pea and oat hay	1.26	5.17
25 lbs. mangels	.25	1.68
9 lbs. rolled wheat	.94	6.58
	2.45	13.43

5.

	Protein.	Fuel.
13 lbs. pea and oat hay	1.26	5.17
25 lbs. carrots	.27	2.20
4 lbs. bran	.50	2.02
6 lbs. shorts	.65	3.90
	2.68	13.29

“Both the above are excellent rations, and the materials in them can be produced at reasonable prices in the wheat sections. If we use corn silage instead of roots we have:

6.

	Protein.	Fuel.
13 lbs. pea and oat hay	1.26	5.17
25 lbs. corn silage	.22	3.39
4 lbs. bran	.50	2.02
6 lbs. shorts	.65	3.90
	2.63	14.48

“Our experience on the Station farm indicates that corn silage is much cheaper than roots in this immediate vicinity.

“Since orchard grass does well as a hay grass in the wheat section, let us try it in a ration.

7.

	Protein.	Fuel.
15 lbs. orchard grass hay	.71	6.28
28 lbs. pea and oat silage	.95	4.42
6 lbs. barley	.53	4.11
	2.29	14.81

"The next shows how brome hay may be utilised.

8.

	Protein.	Fuel.
8 lbs. brome hay	.36	3.52
8 lbs. alfalfa	.86	3.39
20 lbs. corn silage	.22	3.39
6 lbs. bran	.31	3.04
3 lbs. shorts	.35	1.95
	2.10	15.29

"Pea and oat hay could be used instead of the alfalfa, and roots instead of silage in this ration; also wheat chop instead of shorts.

"HOW TO BALANCE A RATION.

"*Use of Nutritive Ratio.* Suppose a farmer has timothy hay, alfalfa hay, and oats, and desires to feed heavily-worked horses a ration that shall contain all the protein and fuel they need, how much of each shall he feed? Of course, the amount of the feed will depend on the size of the horses, the amount of work they are doing, and to some extent on the individuality of the horse. Let us assume a ration for a thousand-pound horse, at heavy work, as follows, and see if it has the proper nutrients (a ration is a day's feed):

	Protein.	Fuel.
8 lbs. timothy hay	.23	3.55
8 lbs. alfalfa hay	.86	3.39
10 lbs. oats	.93	5.77
	2.02	12.71

"By consulting the table of feeding standards, we find that a thousand-pound horse at heavy work requires 2.8 lbs. protein and 15.2 lbs. fuel daily. The above ration is too low in both classes of nutrients. Let us add 4 lbs. of oats:

1st ration	2.02	12.71
4 lbs. oats	.37	2.31
	2.39	15.02

"We have now enough fuel, but not enough flesh formers. Now comes in the use of the nutritive ratio. The nutritive ratio of this ration is $15.02 \div 2.39 = 6.3$. The ratios of the three feeding stuffs may be found by consulting the last column of the table of digestible constituents of feeding stuffs, and are as follows:

Timothy	15.3
Alfalfa	3.9
Oats	6.3

"The ration we want has a ratio of $15.2 \div 2.8 = 5.43$. The ratio of the ration we have is 6.3, and we now wish to reduce it to 5.43. Since the ratio of oats is the same as that of the ration, it will not change the ratio at all to increase or decrease the amount of oats in the ration. But if we increase the amount of alfalfa it will lower the ratio, because the nutritive ratio of alfalfa is lower than that of the ration. We can also decrease the ratio by feeding less timothy. But as the total amount of nutriment is about what we want, the best way is to feed less timothy and more alfalfa. One pound of alfalfa contains .108 lb. protein, while a pound of timothy contains only .029 lb. If we take out one pound of timothy and replace it with a pound of alfalfa, we shall increase the protein by the difference of these numbers, or .108 - .029=.079 lb., or practically .08 lb. But we want to increase the protein from 2.39 to 2.80 lbs., or .41 lb. in all. To secure this increase we must therefore exchange 5 lbs. of timothy for 5 of alfalfa, which gives us:

	Protein.	Fuel
3 lbs. timothy hay	.09	1.33
13 lbs. alfalfa hay	1.40	5.51
14 lbs. oats	1.30	8.07
	2.79	14.91

"This gives us very close to the ration recommended in the table of standards, and illustrates the method used in calculating balanced rations of all kinds. A little practice at this kind of work makes it much less difficult. The rations in this bulletin, however, have been calculated by means of a mechanical appliance recently invented by the writer, which makes the work mere pastime. This appliance will be fully described in a bulletin shortly to be issued, so that anyone with a little ingenuity in handling tools may construct one for himself.

"FEEDING HORSES.

"The last ration above would indicate that very few heavily-worked horses are properly fed in this state. In the wheat sections, horses are usually fed on oats and either grain hay or timothy hay during the ploughing season, and on headed grain during the threshing season. In the alfalfa districts, they are frequently fed nothing but alfalfa the year round. Let us examine a few of these rations for heavily-worked horses and see how they compare with the rations recommended by those who have studied the matter.

	Protein.	Fuel.
Standard rations	2.80	15.20
25 lbs. headed wheat	1.96	15.58
20 lbs. timothy hay 15 lbs. oats	1.97	17.54
20 lbs. wheat hay 15 lbs. oats	2.07	18.10

"It is not difficult to see why our horses fall away so rapidly when heavily worked. It is because the small amount of protein fed them is largely burned for producing energy, and the wasting tissues are not properly nourished. In the case of the alfalfa-fed horse, we have the following:

	Protein.	Fuel.
26 lbs. alfalfa hay	2.8	11.0
30 lbs. alfalfa hay	3.2	12.7
34 lbs. alfalfa hay	3.7	14.4

"Twenty-six pounds of this hay furnishes the right amount of protein, but falls short of supplying the 15 lbs. of fuel required. Thirty-four pounds contain amout as much total nutrients as needed, but the proportion of protein is very high. In the case of horses, this is very objectionable. Feeders tell me that horses fed on alfalfa hay often have trouble with their kidneys, and it is not strange that they should, for when protein is burned in the body it produces urea, which is removed from the system through the kidneys. It seems that the kidneys of horses are more sensitive than those of cattle, for cattle thrive on alfalfa hay alone, though they do not put on much good solid fat, for this feed is deficient in carbohydrates and fat, from which the fat of the body seems to be made.

"The horses receiving this ration are worked every other day, and weigh 800-900 lbs. On the work day the grain is increased and the roughage decreased, the opposite change being made on the days when no work is done. The following rations, materials for one or more of which may be had in all parts of this state, furnish sufficient nutriment for horses at medium hard work:

1.

	Protein.	Fuel.
16 lbs. orchard grass hay	.75	6.70
12 lbs. oats	1.12	6.92
	1.87	13.62

2.

	Protein.	Fuel.
16 lbs. brome hay	.72	7.05
12 lbs. oats	1.12	6.92
	1.84	13.97

3.

	Protein.	Fuel.
16 lbs. tall meadow oat grass	.90	5.59
12 lbs. oats	1.12	6.92
	2.02	12.51

4.

	Protein.	Fuel.
8 lbs. alfalfa hay	.86	3.40
8 lbs. wheat hay	.27	3.86
10 lbs. oats	.93	5.77
	2.06	13.03

"The two following rations, commonly fed to working horses in the Palouse Country, are rather low in protein:

	Protein.	Fuel.
18 lbs. timothy hay	.52	8.00
10 lbs. oats	.93	5.77
	1.45	13.77

	Protein.	Fuel.
16 lbs. wheat hay	.54	7.71
12 lbs. oats	1.12	6.92
	1.66	14.63

"*Horses not at work.* Young, growing stock always need more nutriment in proportion to weight than mature animals under similar conditions. The following remarks concerning idle horses do not, therefore, apply to young horses that are still growing. Their case will be considered later. In large cities there are many firms that own hundreds or even thousands of horses. It is a matter of business economy on their part to understand and apply scientific principles in feeding horses, and it is from the experience of such firms that much of our knowledge concerning the amount of nutriment needed by work horses comes. Some of these have conducted careful experiments along this line. The results of many such experiments are reported in Prof. Henry's book on Feeds and Feeding, and anyone who has considerable numbers of horses to feed should by all means study this book.

"It is generally considered sufficient to feed an idle horse the following amounts of digestible nutrients per thousand pounds live weight daily:

"STANDARD MAINTENANCE RATION.

Protein ----------------------------------	.7 lbs.
Fuel --	8.3 lbs.

"This ration furnishes enough protein to keep the tissues of the body in proper repair, and enough heat and energy to keep the body warm and to maintain the ordinary vital activities, such as breathing, beat of the heart, digesting food, etc.; but it does not furnish enough to permit of growing new tissue, or of doing any external work except a small amount of exercise. Yet some horses [illegible] to be able to gain a small amount of flesh even on this ration, if they are well cared for, and have no work to do.

"The maintenance ration (ration for mature, idle animals) used by the Paris Cab Company above referred to is as follows:

	Protein. lbs.	Fuel. lbs.
.84 lbs. beans ----------------------------	.17	.47
3.91 lbs. oats ----------------------------	.36	2.26
2.88 lbs. corn ----------------------------	.23	2.20
.57 lbs. corn cake ------------------------	.15	.23
2.07 lbs. hay -----------------------------	.11	.85
1.12 lbs. straw ---------------------------	.02	.50
	1.04	6.51

"These horses, as above stated, weigh 800-900 lbs. The above is the average ration, not necessarily the ration for any one day. In this country idle horses are usually fed only roughage, and as the labour of digestion is greater for coarse materials than for concentrated food, it is necessary to feed slightly more digestible nutrients in order to furnish the extra energy required for digesting the coarse material. The following are all fairly satisfactory:

"RATIONS FOR MATURE, IDLE HORSES.

(The amounts given are the daily feed per 1,000 lbs. live weight.)

Standard ration ----------------------------	Protein.—lbs.	Fuel—lbs.
(1)—20 lbs timothy hay -------------------	.70	8.30
(2)—18 lbs. wheat hay --------------------	.58	8.84—low in pro.
(3)—18 lbs. oat hay ----------------------	.61	8.66—low in pro.
(4)—18 lbs. meadow fescue hay -----------	.72	8.40—well balanced.
(5)—18 lbs. brome hay --------------------	.76	8.50—well balanced.
(6)—20 lbs. red top hay ------------------	.81	7.90—well balanced.
(7)—{14 lbs. straw	.78	8.34—well balanced.
5 lbs. alfalfa hay} ----------------------	.74	8.34—well balanced.

"*Young, Growing Horses.* In addition to a maintenance ration, growing animals, in order to develop properly, must be supplied with material for making new growth. The material needed for this is protein. But if we increase the protein of a ration without increasing the fuel constituents, a larger proportion of the protein will be burned as fuel, and the tissues will not get it. If we increase the protein enough to allow for this burning we get so much that there is danger of kidney troubles. The safest and ordinarily the best way to do is to increase the protein to what is needed, and then increase the fuel so that it will be burned, and thus protect the protein from burning.

"Colts should ordinarily be given all the hay they will eat, and an amount of grain depending on age and size, but at all times enough to keep them growing rapidly and to retain what we call their colt form. If they are once allowed to run down in condition while they are growing rapidly, they will never afterwards regain the elegance of form found in a well-kept colt. If properly nourished till mature, they will retain this form to a greater or less degree till they begin to show the effects of age.

"*Food and Milk.* It is generally supposed that the character of the food has much to do with the richness of the milk. Careful experiments indicate that this is not true. As a rule, the richness of the milk the cow gives depends more on the individuality of the cow than on any other factor. When a cow is subjected to excitement of any kind, as when chased by a dog, when taken to the show yard, etc., very great changes in the composition of her milk may be looked for. Also, when changes are made in her food, especially if something very unusual is introduced into the food, the character of the milk may temporarily undergo a change. Long series of observations indicate that when cows are on succulent pastures, as in May and June, their milk is not quite so rich as when on dry feed in the winter. When a herd of cows give milk below the legal standard (3 per cent. of fat), about the only remedy is to introduce into the herd a few head of cows known to give richer milk.

"*Interdicted Feeds.* There are certain substances that have such injurious effects on milk that it is questionable whether they should ever be fed to dairy cows. Yet many feeding stuffs that would otherwise be injurious may be fed with proper precaution. Bad flavours in milk are often due to odours in the barn where the milking is done. Hence, in feeding any substance with a distinct odour, such as silage, for instance, always wait until the milk has been removed from the barn. A. X. Hyatt, one of the leading practical dairymen of Wisconsin, says that turnips, and many other things that sometimes taint the milk, may be fed with impunity if the above rule is observed. Feed them after milking, and at least ten hours before the next milking.

"In feeding wet brewers' grains, the greatest care should be exercised to prevent contamination of the milk. They should never be fed after fermentation has started in them, and vats, troughs, etc., with which the wet grains come in contact, should be carefully looked after. Many dairymen will not feed the wet grains because of the effects produced in the milk from small particles of the material that necessarily get into it from the air of the milking place.

"*Feeding Grains Wet or Dry.* It has generally been found that, in the case of hogs, they will eat more of soaked grain than of dry, hence it is advisable to soak grain for hogs. It is certainly wrong, however, to suppose that grain is more nutritious after it has stood in water long enough to sour and begin to rot. The question whether a cow's grain feed be dry or in the form of a mash, seems not to be an important one, providing the cow is in normal health.

"*Chopping Fodders and Grains.* There can be no question but that, on the whole, it pays to chop grain before feeding, at least for pigs and cows. Oats are especially valuable for pigs and cows when well ground. In general, when grains pass through animals undigested, it is better to chop, unless the droppings of the animals are fully worked over by other animals. The principal object of cutting up hay and fodder is to mix up the coarser, less palatable portions with the rest, thus causing the food to be eaten up cleaner. Long straw of any kind is wasted more or less by being thrown from the rack. A good fodder cutter and a feed mill ought to form part of the equipment of every extensive dairy farm.

"*Value as Fertilisers.* The three ingredients that render manure valuable are nitrogen, potash, and phosphoric acid. Our farmers have not yet, as a rule, learned the value of fertilisers; they are content, for the most part, to practise a system of cropping that robs the soil by slow degrees of the elements that enable it to produce bountiful crops, all heedless of the absolute certainty that in the near future this fertility must be restored to the soil at great expense. It will be of some value to our more progressive farmers to know how much fertilising material our feeding stuffs contain.

"In those states in which fertilising materials must be purchased and applied to the land annually, it is estimated that, in ordinary mineral fertilisers, as bought on the market, a pound of nitrogen costs on the average about 12 cents; potash, 5 cents, and phosphoric acid 5 cents. Now we can recover in the manure three-fourths to nine-tenths of the fertilising materials in the food; it is easy to see, therefore, that those foods which are rich in nitrogen also make the most valuable manure.

"The following table gives the value of the manure made by feeding one ton of each of the foods named, assuming that three-fourths of the fertilising ingredients of the food are recovered in the manure, and attaining the values above indicated to these fertilising materials:

VALUE OF MANURE FROM ONE TON OF FOOD.

Timothy hay	$3 58	Dry carrot tops	9 75
Fodder corn	4 23	Wheat bran	6 89
Vetch hay	6 57	Barley straw	4 00
Pea meal	6 90	Alsike clover	6 39
Red top hay	3 19	Orchard grass hay	4 08
Red clover hay	5 97	Linseed meal	12 00

"These figures give a general idea of the value of the manure that may be obtained from common feeding stuffs. By comparing the composition of those given with others in the table giving the digestible ingredients of feeding stuffs, a close approximation of the manurial value of any feeding stuff there given may be made.

"Other things being equal, the food that is richest in nitrogen will make the most valuable manure.

TABLE OF DIGESTIBLE CONSTITUENTS OF FEEDING STUFFS.

Figures are amounts in one pound of feed.

Feeding Stuffs.	Dry Matter.	Flesh-producers—Protein.	*Fuel—Heat and energy producers.	Total digestible nutrients.	Nutritive ratio.
Concentrates.	lbs.	lbs.	lbs.	lbs.	
Grains, bran, etc.—					
Corn, kernels	.900	.079	.762	.841	9.6
Corn meal	.864	.070	.736	.806	10.6
Corn and cob meal	.849	.065	.628	.693	9.8
Barley	.889	.087	.682	.769	7.9
Buckwheat	.874	.078	.548	.626	7.0
Buckwheat bran	.895	.074	.347	.421	4.7
Oats	.892	.093	.577	.670	6.3
Sorghum seed	.872	.070	.591	.661	8.5
Rye	.884	.083	.682	.765	8.2
Rye bran	.884	.060	.421	.481	7.1
Wheat	.894	.102	.730	.832	7.2
Wheat bran, old process	.880	.101	.533	.634	5.3
Wheat bran, roller process	.880	.126	.506	.632	4.1
Wheat shorts	.882	.108	.649	.757	6.1
Wheat middlings	.897	.113	.655	.778	5.9
Feeds rich in protein—					
Brewers' grains, dry	.911	.162	.474	.636	3.0
Buckwheat shorts	.889	.211	.459	.670	2.2
Buckwheat middlings	.873	.220	.455	.675	2.1
Buffalo gluten meal	.914	.185	.638	.823	3.4
Chicago gluten meal	.922	.305	.547	.852	1.8
Cocoanut oilcake meal	.853	.157	.535	.692	3.6
Cocoanut seed oilcake	.901	.411	.402	.813	1.0
Cotton seed	.897	.125	.689	.814	5.5
Cotton seed hulls	.889	.003	.369	.372	123.0
Cotton seed meal	.918	.372	.444	.816	1.2
Flax seed	.908	.206	.823	1.029	4.0
Gluten meal	.904	.250	.620	.870	2.5
Linseed oil meal, old process	.908	.283	.488	.771	1.7
Linseed oil meal, new process	.899	.272	.300	.662	1.4
Malt Sprouts	.904	.198	.400	.598	2.0
Pease	.895	.200	.562	.762	2.8
Sunflower seed	.925	.121	.860	.981	7.1
Roughage—Dry Materials.					
Grain hay—					
Wheat hay	.914	.034	.482	.516	14.2
Oat hay	.878	.041	.467	.508	11.4
Rye hay	.850	.064	.482	.546	7.5
Barley hay (common)	.893	.046	.469	.515	10.2
Barley hay (beardless)	.935	.063	.486	.549	7.7

TABLE OF DIGESTIBLE CONSTITUENTS.—Continued.

Figures are amounts in one pound of feed.

Feeding Stuffs.	Dry Matter.	Flesh-producers—Protein.	*Fuel—Heat and energy producers.	Total digestible nutrients.	Nutritive ratio.
Hay from legumes—					
Alfalfa hay	.890	.108	.424	.532	3.9
Aliske clover hay	.897	.079	.440	.519	5.6
Hairy vetch hay	.840	.162	.325	.487	2.0
Pea hay—cut in bloom	.850	.128	.355	.478	2.9
Pea and oat hay	.852	.097	.410	.507	4.2
Pea and barley hay	.850	.092	.422	.514	4.6
Red clover hay	.917	.081	.438	.519	5.4
Vetch hay (common spring vetch)	.887	.105	.444	.549	4.2
Vetch and oat hay	.859	.092	.392	.484	4.3
Yellow trefoil	.840	.118	.[illegible]6	.594	4.0
Hay from grasses—					
Brome grass (Bromus inermis)	.850	.045	.440	.485	9.8
English rye grass hay	.891	.055	.413	.468	7.5
Hungarian grass hay	.927	.045	.476	.521	10.6
Italian rye grass	.857	.071	.446	.517	6.3
Kentucky blue grass (June grass)	.923	.059	.436	.495	7.4
Mesquite (see velvet grass).					
Meadow fescue	.800	.042	.471	.513	11.2
Millet	.850	.040	.497	.537	12.4
Orchard grass	.895	.047	.418	.465	8.9
Reed canary grass	.850	.056	.454	.510	8.1
Red top	.901	.039	.417	.456	10.7
Tall meadow oat grass	.857	.056	.349	.405	6.2
Timothy	.892	.029	.444	.473	15.3
Velvet grass (Holcus lanatus)	.724	.055	.345	.400	6.3
Coarse fodders—					
Corn fodder (stalks, leaves and ears)	.605	.022	.345	.367	15.7
Corn Stover (stalk and leaves only)	.544	.015	.263	.278	17.5
Sorghum fodder	.570	.024	.316	.340	13.2
Straw—					
Barley straw	.900	.014	.444	.458	31.7
Buckwheat straw	.901	.023	.390	.413	17.0
Flax straw	.840	.069	.335	.404	4.9
Oat straw	.908	.016	.432	.448	27.0
Rye straw	.928	.007	.436	.443	62.4
Wheat straw	.938	.010	.391	.401	39.1
Pea straw	.842	.036	.341	.377	9.5
Miscellaneous dry feeds—					
Sugar beet pulp (dry)	.936	.097	.730	.827	7.6

TABLE OF DIGESTIBLE CONSTITUENTS.—Continued.

Figures are amounts in one pound of feed.

Feeding Stuffs.	Dry Matter.	Flesh-producers—Protein.	*Fuel—Heat and energy producers.	Total digestible nutrients.	Nutritive ratio.
Succulent Materials.					
Silage—					
Alfalfa silage	.282	.038	.137	.175	3.6
Clover silage	.280	.028	.153	.181	5.5
Corn silage	.209	.009	.135	.144	15.0
Sorghum silage	.238	.007	.148	.155	21.1
Pea and oat silage (oats in bloom, pease beginning to form seed)	.162	.026	.085	.111	3.3
Pea and oat silage (oat grains half grown, pease with full grown seeds)	.299	.034	.158	.192	4.4
Roots—					
Artichokes	.200	.020	.172	.192	8.6
Carrots	.114	.011	.088	.099	8.0
Mangels	.098	.010	.067	.077	6.7
Parsnips	.117	.016	.116	.132	7.3
Potatoes	.211	.014	.167	.181	11.9
Rutabagas	.114	.010	.085	.005	8.5
Sugar beets	.135	.011	.104	.115	9.5
Turnips	.095	.010	.076	.086	7.6
Green fodders—					
Alfalfa	.282	.038	.137	.175	3.6
Alsike clover	.252	.027	.144	.171	5.3
Barley	.259	.018	.111	.129	6.2
Brome grass	.320	.020	.179	.199	9.0
Corn	.200	.011	.133	.144	12.1
Hairy vetch (in full bloom)	.315	.034	.156	.190	4.6
Hungarian grass	.277	.019	.156	.175	8.2
Italian rye grass	.270	.022	.131	.153	6.0
Kentucky blue grass	.349	.029	.210	.239	7.2
Oats in bloom	.250	.018	.129	.147	7.2
Oats (beginning to ripen)	.393	.024	.196	.220	8.2
Orchard grass	.300	.015	.125	.140	8.4
Pease (seeds nearly grown)	.145	.031	.065	.096	2.1
Pease and oats (oats in bloom, pease beginning to form seed)	.180	.026	.093	.119	3.6
Pease and oats (oat grains half grown, pea seed grown)	.299	.034	.158	.192	4.4
Rape	.140	.015	.085	.100	5.7
Red clover	.280	.028	.153	.181	5.5
Red top	.377	.019	.227	.246	11.9
Reed canary grass	.348	.018	.191	.209	10.6
Rye	.212	.021	.150	.171	7.1
Sorghum	.206	.008	.136	.144	17.0
Spring vetch	.199	.030	.076	.106	2.5
Timothy	.318	.015	.199	.214	13.3

TABLE OF DIGESTIBLE CONSTITUENTS.—Concluded.

Figures are amounts in one pound of feed.

Feeding Stuffs.	Dry Matter.	Flesh-producers—Protein.	*Fuel—Heat and energy producers.	Total digestible nutrients.	Nutritive ratio.
Green fodders—Concluded.					
Velvet grass	.276	.014	.129	.143	9.2
Vetch and oats	.238	.027	.121	.148	4.5
Wheat	.257	.018	.139	.157	7.7
Miscellaneous succulent feeding stuffs—					
Apples	.152	.003	.132	.135	44.0
Apple pomace	.233	.010	.144	.154	14.4
Brewers' grains, wet	.243	.039	.124	.163	3.2
Pumpkins	.145	.004	.073	.077	18.2
Sugar beet pulp, wet	.100	.010	.077	.087	7.7
Milk, etc.—					
Cow's milk	.130	.035	.131	.166	3.7
Skim milk	.096	.038	.066	.104	1.7
Butter milk	.099	.039	.065	.104	1.7
Whey	.066	.010	.064	.074	6.4

*Carbohydrates plus 2¼ times the fat.

INFLUENCE OF FEED ON MILK—WIDE AND NARROW RATIONS,

(From "Feeds and Feeding," by Prof. W. A. Henry, Wisconsin Experiment Station.)

FEED IN RELATION TO MILK.

Possible modifications of Milk by Feed. If feed has any influence on the character of milk, we may suppose these modifications take one or more of the following forms:—

(A.) An increase or decrease in the total quantity of milk yielded:
(B.) Increasing or decreasing the ratio of solids to water in the milk:
(C.) Changing the ratio of one or more components of the milk with relation to the others:
(D.) Changing the chemical or physical character of one or more components:
(E.) Changing the flavour or odour of milk or derivatives from it.

Let us consider these several and possible changes in the order presented.

A.—EFFECT OF FEED ON QUANTITY.

Liberal and Meagre Rations. Most dairymen have learned that, under liberal feeding, the dairy cow is stimulated to the best milk returns within her capacity. So generous is the cow in this particular that dairymen will concede they rarely supply their animals sufficient feed to induce the largest flow of milk possible with all members of the herd. With scanty rations, or those of faulty character, the normal milk flow of the cow is diminished, though she will still yield this fluid for a time while undergoing starvation. Milk being designed for the support of the young, Nature has provided for its supply to the limit of animal endurance.

Influence of Character of Rations. The abundance and proportion of the several nutrients in the ration, and the quantity of innate matter it contains, may effect the flow of milk. This is illustrated by an experiment at the Ontario Agricultural College by Dean, in which six cows were divided into three lots of two each. The ration marked (I.) consisted exclusively of coarse feed, supplying more carbohydrates and less protein than the cow required. It contained a large quantity of inert matter. Ration (II.) contained an ample supply of carbohydrates and an over-supply of protein, the latter being contained in rich, heavy, oil meals. Ration (III.) contained an excess of nutrients. By alternating the rations for the three groups of cows, the influence of a decreasing milk flow was eliminated from the results, which were as follows:

Feeding an Improperly-compounded and a Well-balanced Ration to Dairy Cows.—Ontario Agricultural College.

Ration.	Total digestible matter.	Nutritive ratio.	Average live weight.	Daily yield of milk.	Fat.
	lbs.	lbs.	lbs.	lbs.	lbs.
(A.) Silage, 50 lbs.; hay, 6 lbs.; bran, 5 lbs.	10.79	1: 8.4	1.068	29.7	3.82
(I.) Silage, 30 lbs.; oat straw, 20 lbs.; hay, 10 lbs.	15.89	1:25.6	1,014	21 8	3.67
(II.) Hay, 20 lbs.; oil meal, 4 lbs.; cotton - seed meal, 5 lbs	14.76	1: 3.9	1,091	29.3	3.49
(III.) Hay, 20 lbs.; pea meal, 4 lbs.; oat meal, 5 lbs.; corn meal, 8 lbs.	20.27	1: 6.8	1.110	31.8	3.25

Under (II.) there was abundant nutrition, but the oil meals given were there was an average daily milk yield of 29.7 pounds. When ration (I.) was fed, the cows dropped to 21.8 pounds of milk. In this ration we find a liberal allowance of carbohydrates, with too little protein and too much inert matter. Though the cows were filled with feed, they were poorly nurtured. Under (II.) there was abundant nutrition, but the oil meals given were heavy in character and too liberal in quantity for the best results, though the milk flow was increased to nearly the normal. With (III.) we have a better-balanced ration; the cows were over-fed, but the better character of the ration secured larger returns than were possible under previous feeding, the amount of milk now reaching 31.8 pounds daily. It is evident that the character and quantity of feed directly affect the flow of milk, and over-feeding or the use of improperly-compounded rations may bring poor results as well as under-feeding.

Caring for the Cow. While our purpose is to cover the question of feeding, that subject cannot be wisely considered unless certain matters concerning the handling of the cow be first discussed. Though it cannot be affirmed that the digestion of food by the cow is affected by the character of her surroundings, it is certain that the yield of milk and its character are directly influenced thereby, so that the results to the dairyman are the same. Good returns from a given supply of feed, no matter how abundant and satisfactory, cannot be looked for unless the cow also has comfortable quarters and is intelligently handled.

Necessity for Shelter. In another article it is shown that the steer, gorged with food, and each day adding to the layer of heat-holding fat just beneath the skin, can withstand considerable cold, often showing preference to the open shed to the close stable. The condition of the dairy cow is in strong opposition to this, her system being relaxed by the annual drain of maternity and the semi-daily heavy loss of nutrients drawn from her in the abundant flow of milk. The observant stockman will at once detect the fundamental difference in the condition of the dairy cow and the fattening ox in regard to ability to withstand exposure to the weather. To be profitably managed and yield wholesome milk, a cow must be comfortably housed in a well-ventilated stable in winter, the temperature of which should not fall below forty degrees as the minimum, or rise above sixty degrees as the maximum. In such a stable, provided with abundance of sunlight, she is in condition, so far as environment is concerned, to yield the highest returns for the feed given.

Exercise. With the fattening animal soon to be slaughtered, confinement, more or less close, is advisable, since it prevents waste of tissue and conserves the feed. The end in view with the dairy cow is radically different, for she must give milk almost daily during the whole period of her usefulness, and the milk so yielded must be wholesome in character, fit in all particulars for the most delicate. It is certainly reasonable to hold that the cow cannot maintain the high standard of bodily health and vigour essential to the production of healthful milk when she is closely confined in the stable for long periods without opportunity for outdoor air and exercise. She should have several hours' outdoor exercise daily, or in quarters other than where she passes most of her time, the change affording opportunity to breathe the pure air and drink in the sunshine, as well as to exercise the muscles which have not been called into action during confinement, and resting those taxed by occupying a forced position in the narrow stall or stanchion.

Professor Roberts' System. At the north, where the winters are severe, it is difficult to give cattle the requisite exercise without forcing them to undergo exposure during inclement weather. At the Cornell Station, Professor Roberts has for years followed a plan of seemingly great value in its teachings to the dairymen of the north. Here the cows stand in stanchions while feeding and being milked, but afterwards turned into a covered enclosure, where they are free to stand or lie at will; thus they have a feed room and an exercise room, each specially adapted to its purpose. The accumulations from the horse stable are spread over the floor of the covered yard, and this in turn is covered liberally with straw, on which land plaster is sprinkled to prevent odours rising. This perfect system of saving manure should of itself, in a few years, pay for the cost of the additional space required. By this plan, the stable proper can be reduced to the smallest size compatible with holding the animals while being milked and fed. It can be kept scrupulously clean and properly aired, since the cows are out of it several hours daily. The animals come to their provender at meal time with the best of appetites, and return to their larger quarters to ruminate in comfort.

Regularity and Kindness. To skilful feeding the successful dairyman will add regularity and kindness in the management of his herd. The true dairy cow is easily affected by unfavourable conditions.

Babcock, of the Wisconsin Station, after careful studies of cows in many ways, writes: "The elaboration of milk does not proceed at a uniform rate from milking to milking, but is most active at the time of milking, and is dependent not only upon the stimulus which the milk glands derive from the manipulation of the teats and udder, but upon the nervous condition of the animal at the time of milking.

"In consequence of this, slight changes in the conditions under which the milking is done may have a decided influence upon both the yield and quality of milk. As a general rule the quality of milk, measured by the per cent. of fat which it contains, is more sensitive to changes of this kind than is the yield of milk. Among the changes which appear to have most influence in this respect, the following are of special importance, viz.: change in the interval between milkings, and in the rate of milking, change of milkers and manner of milking, especially if the manipulation of the teats and udder be different; change of environment and any circumstance which excites or even slightly disturbs the animal at the time—excitement between milkings, if the cow has become quiet before milking, appears to have comparatively little influence. As would be expected there is a great difference between cows in this respect, some being very sensitive, while others are scarcely affected at all. In our exepriments cows that have been giving milk for a long time have been less sensitive in this respect than fresh cows that were giving a large quantity of milk, but this may have been due to individual characteristics of the animals tested, and not to the advanced period of lactation. I would recommend, therefore, in order to obtain the best results from any cow, that first of all she be treated kindly, all sources of excitement being avoided as far as possible. She should also be fed and milked at regular intervals by the same person, and all conditions should be maintained as nearly uniform as possible at all times. It is my opinion that kind treatment and pleasant surroundings will have a greater influence upon the quality of milk than the kind of food, provided the ration given contains sufficient nutriment for the maintenance of the animal."

Frequency of Feeding. The frequency with which feed should be supplied cows has not yet been settled, and perhaps never will be until members of the human family agree on the number of meals a day and the character of each best suited to their own needs. From the large size of the paunch and the apparent necessity for rumination, it does not seem essential to supply feed many times a day. The common practice of feeding twice a day, once in the morning and once late in the afternoon, with an armful of roughage to pick over at midday, appears a reasonable one, and conforms well with the labour requirements of the stable. There are dairymen who are never through feeding. They give first a little of this, then a little of that, keeping themselves busy in the stable most of the day caring for their cows. The cows of such persons usually yield good returns, their owners ascribe success to their particular system of feeding, when, instead, it is the general good care and not the particular system that should be credited. As with mankind, habit rules in these matters; and any system which is reasonable, having once been established, should not be set aside unless the feeder is sure of advantage from the change, which should be gradual, if possible.

Order of Feeding Concentrates, Roughage and Water. The digestive tract of the cow is provided with a large storage room for the reception of food. In the paunch the various articles swallowed are rapidly and thoroughly commingled by the churning action of that organ. Hay and grain are soon thoroughly intermixed, and gradually soften in the warm liquid there so abundant. This being true, the order of supplying the several constituents of the ration is not of importance from a physiological standpoint. The cow seems best satisfied when receiving the concentrates or more appetizing portion of the ration first. And after this has been disposed of she begins, in contentment, to chew the hay, silage or other roughage placed before her. As barn operations are usually conducted, watering follows dry feed.

Preparation of Feed. As the dairy cow, when giving a large quantity of milk, is accomplishig much work, it is best to prepare the feed for rapid mastication, when possible, without too great cost. Grain should generally be ground and roots sliced. Where labour is high-priced, as at the West, it is preferable in many cases to feed the cow in the most simple manner, even though as large returns do not follow.

Dry Feed. Cows take kindly to dry feed, and as a rule prefer it to that in a sloppy condition. Because of the thorough admixture of the contents of the rumen, where there is abundance of moisture, there seems no occasion for converting meal into slop before feeding. By supplying the feed dry the mangers can be kept more wholesome, with less labour in administering it.

Liberal Feeding. The dairyman should never forget that about 60 per cent. of all the cow can eat is required to sustain her body, and only after this amount is provided can there be any returns to him. Having incurred the expense necessary to operate a dairy, in the purchase of lands, buildings and cows, he is certainly short-sighted who will withhold any part of the 40 per cent. of provender, which will produce returns for himself. When the dairyman has reached the point of liberal feeding he should begin to study the individual needs of the members. Since some cows can profitably utilise more feed than others the distribution of concentrates should proceed with discrimination, some animals being fed more and others less than the average of the herd.

Confinement During Heated Periods. Whether or not the dairyman practise soiling, there are periods in summer when the cows should be in the stable during the day and turned to pasture at night. During heated periods, when flies are troublesome, cows fall off greatly in their milk, this shrinkage measuring in some degree their suffering. At such times it is best to place them in darkened stables and supply green forage, supplemented with meal For exercise turn them out at night in yard or pasture. Knowing how difficult it is to bring cows back to their normal flow after these periods of shrinkage, the wise dairyman will not be unwilling to provide for their comfort at such times.

Water. That the cow requires a liberal supply of water goes without saying; for not only must the wants of the body be met, but a considerable quantity is drained off with the milk, twice daily. Being creatures of habit, cows can subsist when supplied with water once each day, but an opportunity to reach the trough morning and evening is preferable. It is becoming quite common to supply water to cows, individually, in small troughs or vessels placed in front of them in the stable. If this supply can be kept wholesome the practice is satisfactory; but close inspection will show that in many cases, perhaps a majority, these individual watering devices are traps for filth and foul-smelling water. The dairyman should convince himself, by using his nose as well as his eyes, that the water in these devices is pure and wholesome.

Whatever method of watering is employed, let uniformity prevail, the cows having opportunity to secure all they wish without fear of one another or of being forced to undergo hardship in securing it. Often the dairyman boasts of a spring or creek at which his cows may help themselves. These sources of supply are often a long way from the stables, and the animals are daily forced to make journeys to them, often in inclement weather, thereby experiencing discomfort and actual hardship. A good well with wind-mill will prove superior to springs and brooks in most cases, because, with these, water can be delivered when and where it is needed.

Salt. Though little is known from investigation on this subject, it is evident from the extreme fondness of dairy cows for salt that this article should be regularly and abundantly supplied them. The necessity for salt increases with the amount of concentrates given. From three-fourths to one ounce of salt daily is a reasonable allowance. It should be supplied daily rather than at irregular or infrequent periods in larger quantities. The practice of placing large lumps of rock salt where they are accessible to the herd is satisfactory, provided the salt is kept under cover in a clean box.

FEED FOR THE DAIRY COW.

Necessity for Concentrated Feed. The dairy cow, when yielding a liberal supply of milk, should be regarded as an animal at hard labour. We have seen that the work-horse must have more grain and less roughage as his labour increases, and the same is true with the cow. A portion of the provender must, therefore, take the form of grain or concentrates. Moreover, if she is yielding a large amount of milk, *i. e.*, working hard, it is best to aid her by reducing the grain to fineness by grinding. The dry cow is doing little work and can subsist on less feed, and this may be coarser in character.

The Relation of Concentrates to Roughage. The relation of concentrates to roughage should always be borne in mind. The rule should be to feed nearly as much roughage as the cow will consume without overtaxing her; then supply sufficient concentrates to bring the digestible matter up to the required standard. About four-tenths of the digestible nutrients should be given in the form of concentrates, and six-tenths in the roughage. It will not do to feed all grain in expectation of better returns. A satisfactory ration must possess a certain bulk or volume, in order to properly distend the abdomen. Without this the processes of digestion cannot proceed normally. This should never be forgotten, even when forcing cows in dairy contests.

Oats. It is not difficult to believe that oats, the most valuable for the horse, are also a prime feed for the dairy cow. The husk of the oat, though carrying little nutrient, renders this grain a feed of light character in the stomach and easy of digestion. With the data given us by Woll, the dairy farmer is in position to easily determine whether he can afford to feed the oats he may grow, or exchange them for bran or other common feeds.

The bye-products of oatmeal factories are valuable just in the proportion in which the kernels of the oat grain appear in them. Often there are sufficient fragments of kernels in these articles to warrant the payment of a fair price for them; but when the hulls only are offered the dairyman would better let them alone, for they are no better than the roughage in his mows and stacks.

Wheat Bran and Middlings. Next to corn, wheat bran is the great cow-feed of this country. Rich in ash and protein, carrying a fair amount of starchy matter, its light, chaffy character renders it the natural complement of heavy corn meal. Though its nutritive constituents approximate those of cotton seed meal, it mixes well with that feed, causing it to lie more lightly in the stomach. The large amount of mineral matter in bran is another factor of much importance in milk production. In milk there is much mineral matter, placed there for the framework of the calf; and bran supplies this more abundantly than most feeding stuffs.

Middlings, like bran, are extensively fed to dairy cows. Being themselves heavy in character, they do not mix well with heavy feeds like cotton seed meal and corn meal. Dairymen will find middlings much relished by cows and yielding satisfactory results. Bran and middlings are conceded by all who have fed them to favourably affect the flow of milk. Cows may be fed as much as six to eight pounds of bran daily, and from four to six pounds of middlings.

Rye. This grain is fed in small quantities to milch cows in Denmark. It is said to have a somewhat deleterious influence on the quality of butter. The same statement applies to rye bran. Not over three pounds of rye bran or ground rye should be fed in one day to milch cows.

Barley. The common grain for milch cows in Denmark is barley and oats, generally sown and harvested together, the proportion of barley and oats in the mixture being 2 : 3 or 1 : 2. Barley alone is not fed extensively to cows, wheat bran being preferred on the score of cheapness and influence on the milk secretion. Barley will prove beneficial to cows fed heavily with roots, since it counteracts their laxative influence. From three to five pounds of ground barley will suffice in the ration of the cow, bran proving an excellent complementary feed.

Brewers' Grains. Fresh brewers' grains constitute one of the best feeds for the dairy cow. She is fond of them, and they influence most favourably the flow of milk. Fed while fresh in reasonable quantity, supplemented by bright hay or corn fodder for dry feed, the grains being supplied in tight feed boxes which can be kept clean, and with all other conditions favourable to the healthfulness of the cow, no valid objections can be raised against this form of feed. From twenty to thirty pounds of wet grains should constitute a day's allowance. Because the grains are low-priced is no reason for over-feeding with them. Corn meal is an excellent complementary feed, two or three pounds being used daily with the grains. Because of their sloppy character, some dry feed should always be supplied with the grains unless cows are at pasture in summer.

Dried brewers' grains can be economically transported, and form an excellent feed for cows. Their purpose in the ration will be largely to supply protein, which they carry in abundance. It seems strange that American dried brewers' grains should find their market largely in distant Germany. Four or five pounds of dried grains will furnish a considerable portion of the protein required in the ration, and prove very acceptable to the cow.

Clover Hay. No dry forage can prove superior to good clover hay for the cow, because of its palatability and its relatively high protein content. This hay should generally be fed long, since it is fresher and shows less dust when so handled than after passing through the feed cutter. From ten to twelve pounds is a sufficient allowance for a day's feed. Corn-fodder, corn-stover, or corn-silage, are complementary forms of roughage.

Timothy Hay. Generally dairymen cannot afford to feed timothy hay, because of the high price it commands compared with its very moderate value for roughage when fed to the cow, and also because of the small yield returned per acre. Where prices are high, if there is timothy hay on hand, let it be sold and fodder corn used in its place. Often a ton of timothy hay can be sold for a sum that will purchase a ton of bran, in which case the bran should be used with fodder corn or other roughage.

Millet Hay. Hay from millet or Hungarian grass, when well preesrved, is useful for feeding if supplied once a day for roughage. Since millet is not rich in protein, not over six or eight pounds should be fed daily. Clover hay is a complementary roughage feed because rich in protein.

Fodder Corn. In this country successful dairying rests largely upon the judicious use of the corn plant for forage. The best forage is secured where the seed grains of corn are planted just thick enough to grow stalks which will carry a generous supply of small ears or nubbins. Harvested at the right time a large yield of forage is secured, which is so palatable that, preserved either as silage or cured in the shock, practically all of the material is available as feed for the cow if rightly handled. Next to the direct care of the herd the greatest study of the dairyman should be in learning to economically grow, harvest and administer the corn plant.

The cow may receive from ten to fifteen pounds of fodder corn daily, with advantage. If this has been grown with a "nubbin" or small ear on most of the stalks, a fair allowance of the roughage will furnish as much grain as should be fed.

Corn Stover. Where corn is grown for the grain, the straw or stover which remains after husking the ears, though of less value than fodder corn, may still serve an important place in the feed stable. Cows are fond of the finer parts of the corn stalk, and if the stover is run through a feed-cutter and not too liberally supplied, but a small part of the stalks will be wasted. Where the stalks are coarse and inert, as they are in the southern part of the Corn Belt and farther South, this statement does not apply, for there corn stalks are not much relished by cows, though in silage form they are readily eaten.

Roots. In Europe dairymen make large use of roots. In this country, where Indian corn flourishes, silage from corn will be found more economical, considering cost of production, and is equally satisfactory with the root crop for feeding cows. Where the dairyman does not have silage it will be well to feed some roots. Mangels are the best for cows and should be pulped or sliced. Canadian dairymen often pulp the roots and mix this with chaffed hay, allowing the mass to stand a day before feeding. From twenty to forty pounds of mangels is a day's allowance. Sugar beets also serve for feeding cows. Being much richer than mangels, a smaller quantity should be fed.

Silage. Silage, principally from the corn plant, is now a factor of first importance on thousands of American dairy farms. That silage is well liked by the cow, that she thrives on it and yields milk liberally, that properly fed it does not impair her health—all these points have been settled in favour of the silo and its product. Since corn silage is rich in carbohydrates and low in protein, clover hay is the common complementary roughage.

The character of silage is such that, even though cows seemingly thrive on it when fed alone, some dry roughage should be supplied with it. In northern latitudes the cow should not be wholly maintained in winter on silage. Good corn silage always contains a liberal supply of ears, and the amount to be fed depends directly upon the proportion of ears to forage. From thirty to fifty pounds is the usual daily allowance for a cow.

Rations for Dairy Cows. The young dairyman scans reports to ascertain what others are feeding their cows; the dairyman with years of experience is not averse to knowing of the practices of others, though he may be slow in changing to that which is new.

In 1894, Woll, of the Wisconsin Station, by correspondence, secured data concerning the rations fed by more than a hundred dairymen scattered over the United States. As most of them were noted in their specialty, we can place no better guide before the reader than a group of rations from this source:—

Colorado.—20 lbs. alfalfa hay, 5 lbs. oat straw, 2½ lbs. wheat bran, 2½ lbs. shorts, 5 lbs. oats, 1½ lbs. cotton-seed meal.

Connecticut.—35 lbs. corn silage, 10 lbs. hay, 3 lbs. bran, 3 lbs. corn and cob meal, 2 lbs. cotton-seed meal, 2 lbs. Chicago gluten meal.

Illinois.—10 lbs. timothy hay, 10 lbs. clover hay, 8 lbs. corn, 1½ lbs. oats.

Indiana.—30 lbs. corn silage, 5 lbs. clover hay, 3 lbs. corn fodder, 1 lb. oat straw, 1 lb. wheat straw, 5 lbs. bran, 2 lbs. oil meal, 2 lbs. cotton-seedmeal.

Iowa.—30 lbs. corn silage, 5 lbs. hay, 5 lbs. corn-fodder, 1 lb. oat straw, 1 lb. barley straw, 5 lbs. ear corn, 2½ lbs. ground oats and barley.

Kentucky.—32.5 lbs. corn silage, 6 lbs. clover hay, 3 lbs. corn fodder, 5 lbs. corn meal, 4 lbs. ship-stuff, 2 lbs. oil meal.

Massachusetts.—40 lbs. corn silage, 5 lbs. English hay, 5 lbs. clover hay, 2 lbs. bran, 2 lbs. gluten meal, 1 lb. cotton-seed meal, 1 lb. oil meal.

Michigan.—27.5 lbs. corn silage, 3½ lbs. clover hay, 3½ lbs. timothy hay, 3.6 lbs. bran, ½ lb. oats, 1 lb. rye, ½ lb. oil meal.

Minnesota.—8 lbs. corn stover, 7 lbs. clover and timothy hay, 5 lbs. sheaf oats, 3 lbs. ruta-bagas, 2 lbs. bran, 3 lbs. oats, 3 lbs. corn meal, 2 lbs. oil meal.

Nebraska.—20 lbs. prairie hay, 10 lbs. corn stover, 5.7 lbs. corn meal, 2.9 lbs. bran, 1.4 lbs. oil meal.

New Hampshire.—10 lbs. clover and witch-grass hay, 10 lbs. corn stover, 5 lbs. unthrashed barley, 2 lbs. corn and cob meal, 2 lbs. shorts, 2 lbs. cotton-seed oil.

New Jersey.—24 lbs. corn silage, 8 lbs. corn meal, 2 lbs. bran, 4 lbs. oats, 2 lbs. oil meal.

New York.—25 lbs. corn silage, 7 lbs. mixed hay, 4 lbs. corn meal, 5 lbs. bran, ½ lb. oil meal, ½ lb. cotton-seed meal.

North Carolina.—30 lbs. corn silage, 8 lbs. fodder corn, 3 lbs. corn meal, 3 lbs. bran, 1 lb. cotton-seed meal.

Ohio.—10 lbs. clover hay, 20 lbs. corn stover, 8 lbs. corn meal, 3 lbs corn and cob meal, 1 lb. bran, 8 lbs. roots.

Pennsylvania.—45 lbs. corn silage, 7 lbs. mixed hay, 6 lbs. bran, 2 lbs. cotton-seed meal.

Texas.—30 lbs. corn silage, 13½ lbs. sorghum hay, 1.3 lbs. corn meal, 2.6 lbs. cotton-seed meal, 2.2 lbs. cotton seed, 1.3 lbs. wheat bran.

Utah.—35 lbs. alfalfa hay, 6⅔ lbs. wheat bran, 3⅓ lbs. barley.

Vermont.—35 lbs. corn silage, 10 lbs. mixed hay, 2 lbs. bran, 3.2 lbs. corn meal, 1 lb. oil meal, 8 lbs. cotton-seed meal.

West Virginia.—48 lbs. corn silage, 2½ lbs. corn and cob meal, 2½ lbs. ground wheat, 2 ½ lbs. oats, 2 ½ lbs. barley meal.

Washington.—15 lbs. alfalfa hay, 7 lbs. bran, 7 lbs. shorts, 2 lbs. malt sprouts.

Wisconsin.—40 lbs. corn silage, 8 lbs. clover hay, 6 lbs. bran, 2 lbs. pea meal.

Canada.—45 lbs. turnips, 7 lbs. wheat chaff, 15 lbs. silage, 2½ lbs. oats, 2½ lbs. pea meal.

AVERAGE DIGESTIBLE NUTRIENTS IN AMERICAN FEEDING STUFFS.

Name of Feed.	Dry matter in 100 lbs.	Digestible nutrients in 100 lbs.		
		Protein.	Carbohydrates.	Ether extract.
Concentrates.	lbs.	lbs.	lbs.	lbs.
Corn, all analyses	89.1	7.9	66.7	4.3
Corn, cob	89.3	0.4	52.5	0.3
Corn and cob meal	84.9	4.4	60.0	2.9
Corn bran	90.9	7.4	59.8	4.6
Wheat	89.5	10.2	69.2	1.7
High-grade flour	87.6	8.9	62.4	0.9
Low-grade flour	87.6	8.2	62.7	.09
Dark feeding flour	90.3	13.5	61.3	2.0
Wheat bran	88.1	12.2	39.2	2.7
Wheat bran, spring wheat	88.5	12.9	40.1	3.4
Wheat bran, winter wheat	87.7	12.3	37.1	2.6
Wheat shorts	88.2	12.2	50.0	3.8
Wheat middlings	87.9	12.8	53.0	3.4
Wheat screenings	88.4	9.8	51.0	2.2
Rye	88.4	9.9	67.6	1.1
Rye bran	88.4	11.5	50.3	2.0
Rye shorts	90.7	11.9	45.1	1.6
Barley	89.1	8.7	65.6	1.6
Malt Sprouts	89.8	18.6	37.1	1.7
Brewers' grains, dried	91.8	15.7	36.3	5.1
Brewers' grains, wet	24.3	3.9	9.3	1.4
Oats	80.0	9.2	47.3	4.2
Oat meal	92.1	11.5	52.1	5.9
Oat feed or shorts	92.3	12.5	46.9	2.8
Oat dust	93.5	8.9	38.4	5.1
Oat hulls	90.6	1.3	40.1	0.6
Flax seed	90.8	20.6	17.1	29.0
Linseed meal, old process	90.8	29.3	32.7	7.0
Linseed meal, new process	89.9	28.2	40.1	2.8
Cocoanut meal	89.7	15.6	38.3	10.5
Sunflower seed	92.5	12.1	20.8	29.0
Sunflower seed cakes	91.8	31.2	19.6	12.8
Rape-seed meal	90.0	25.2	23.7	7.5
Peas	89.5	16.8	51.8	0.7
Cow pea	85.2	18.3	54.2	1.1
Horse bean	85.7	22.4	49.3	1.2

DIGESTIBLE NUTRIENTS.—Continued.

Name of feed.	Dry matter in 100 lbs.	Digestible nutrients in 100 lbs.		
		Protein.	Carbohydrates.	Ether extract.
Roughage.	lbs.	lbs.	lbs.	lbs.
Fodder corn—				
Fodder corn, green	20.7	1.0	11.6	0.4
Fodder corn, field-cured	57.8	2.5	34.6	1.2
Corn stover, field cured	59.5	1.7	32.4	0.7
Fresh grass—				
Pasture grasses (mixed)	20.0	2.5	10.2	0.5
Kentucky blue grass	34.9	3.0	19.8	0.8
Timothy, different stages	38.4	1.2	19.1	0.6
Orchard grass, in bloom	27.0	1.5	11.4	0.5
Redtop in bloom	34.7	2.1	21.2	0.6
Oat fodder	37.8	2.6	18.9	1.0
Rye fodder	23.4	2.1	14.1	0.4
Meadow fescue, in bloom	30.1	1.5	16.8	0.4
Hungarian grass	28.9	2.0	16.0	0.4
Green barley	21.0	1.9	10.2	0.4
Peas and oats	16.0	1.8	7.1	0.2
Peas and barley	16.0	1.7	7.2	0.2
Hay—				
Timothy	86.8	2.8	43.4	1.4
Orchard grass	90.1	4.9	42.3	1.4
Red top	91.1	4.8	46.9	1.0
Kentucky blue grass	78.8	4.8	37.3	2.0
Hungarian grass	92.3	4.5	51.7	1.3
Mixed grasses	87.1	5.9	40.9	1.2
Meadow fescue	80.0	4.2	43.3	1.7
Oat hay	91.1	4.3	46.4	1.5
Marsh or swamp hay	88.4	2.4	29.9	0.9
" "	92.1	3.5	44.7	0.7
Straw—				
Wheat	90.4	0.4	36.3	0.4
Rye	92.9	0.6	40.6	0.4
Oat	90.8	1.2	38.6	0.8
Barley	85.8	0.7	41.2	0.6
Wheat chaff	85.7	0.3	23.3	0.5
Oat chaff	85.7	1.5	33.0	0.7
Fresh legumes—				
Red clover, different stages	29.2	2.9	14.8	0.7
Alsike, bloom	25.2	2.7	13.1	0.6
Crimson clover	19.1	2.4	9.1	0.5
Alfalfa	28.2	3.9	12.7	0.5
Cow pea	16.4	1.8	8.7	0.2
Legume hay and straw—				
Red clover, medium	84.7	6.8	35.8	1.7
Red clover, mammoth	78.8	5.7	32.0	1.9
Alsike clover	90.3	8.4	42.5	1.5

DIGESTIBLE NUTRIENTS.—Concluded.

Name of feed.	Dry matter in 100 lbs.	Digestible nutrients in 100 lbs.		
		Protein.	Carbohydrates.	Ether extract.
Legume hay and straw—Concluded.				
White clover	90.3	11.5	42.2	1.5
Crimson clover	90.4	10.5	34.9	1.2
Alfalfa	91.6	11.0	39.6	1.2
Cow pea	89.3	10.8	38.6	1.1
Pea vine straw	86.4	4.3	32.3	0.8
Silage—				
Corn	20.9	0.9	11.3	0.7
Clover	28.0	2.0	13.5	1.0
Alfalfa	27.5	3.0	8.5	1.9
Grass	32.0	1.9	13.4	1.6
Cow pea vine	20.7	1.5	8.6	0.9
Roots and tubers—				
Potato	21.1	0.9	16.3	0.1
Beet, common	13.0	1.2	8.8	0.1
Beet, sugar	13.5	1.1	10.2	0.1
Beet, mangel	9.1	1.1	5.4	0.1
Flat turnip	9.5	1.0	7.2	0.2
Rutabaga	11.4	1.0	8.1	0.2
Carrot	11.4	0.8	7.8	0.2
Parsnip	11.7	1.6	11.2	0.2
Artichoke (Jerusalem)	20.0	2.0	16.8	0.2
Miscellaneous—				
Cabbage	15.3	1.8	8.2	0.4
Sugar beet leaves	12.0	1.7	4.6	0.2
Pumpkin, garden	19.2	1.4	8.3	0.8
Pumpkin, field	9.1	1.0	5.8	0.3
Rape	14.0	1.5	8.1	0.2

RATIONS FOR DAIRY COWS.

(From Ontario Bulletin 104.)

SOME ONTARIO RATIONS FOR DAIRY COWS.

1. *Shorthorns, Jerseys and Jersey grades.* Average weight of cows, 1,000 lbs.; 6 lbs. bran, 3 lbs. oil meal, 50 lbs. ensilage, 4 lbs. timothy hay, 4 lbs. oat and vetch hay.

A well-balanced ration, though the value of the oat and vetch hay had to be approximated.

2. *Ayrshires.* Average weight of cows, 1,000 lbs.; 4 lbs. bran, 2 lbs. peas, 2 lbs. oats, 1 lb. oil meal, 24 lbs. timothy and clover hay and 10 lbs roots.

Also a fairly well-balanced ration, but it is probable that the quantity of hay has been over-estimated, making the total organic matter too high.

3. *Grade Shorthorns and Jerseys.* Average weight of cows, 900 lbs.; 4 lbs. oats, 1 lb. oil meal, 40 lbs. ensilage, 30 lbs. roots, with cut hay and straw.

4. *Grade Ayrshires.* Average weight of cows, 1,000 lbs.; 8 lbs. bran, 6 lbs. corn and cob meal, 6 lbs. mixed peas, oats and barley, 20 lbs. corn fodder, 20 lbs. mangels, and all the hay and straw they will eat.

5. *Jerseys.* Average weight of cows, 800 lbs.; 9 lbs. bran, 1 lb. peas, 24 lbs. ensilage, 6 lbs. hay, 10 lbs. straw, and 20 lbs. roots.

Too high in organic matter and carbohydrates, but protein and fat satisfactory. No doubt straw has been over-estimated. Reducing the quantity of straw would narrow the ratio and make the ration very well-balanced.

6. *Grade natives.* Average weight of cows, 950 lbs.; 2½ lbs. cotton seed meal, 2½ lbs. linseed, 50 to 60 lbs. ensilage, and 4 to 5 lbs. hay. Sometimes meal ration is 2 lbs. cotton seed meal and 4 lbs. shorts.

Estimated on basis of 2 lbs. cotton seed meal, 4 lbs. shorts, 50 lbs. ensilage and 5 lbs. hay. Too low in all constituents except fat, though nutritive ratio is satisfactory. Slightly increasing the shorts, and adding a little clover hay, would tend to remedy the fault.

7. *Ayrshires.* Average weight of cows, 900 lbs.; 8 lbs. mixed oats, peas, barley and bran, in proportion of 6, 3, 3 and 1; 50 lbs. ensilage, 10 lbs. mixed clover and "beaver-meadow" hay, with an occasional feed of straw and roots.

8. *Jerseys.* Average weight of cows, 750 lbs.; 9 lbs. oats, 60 lbs. ensilage, 6 lbs. hay, with what straw they will eat.

No doubt there is some mistake here in estimating the quantities of fodder, as the ration appears abnormal.

9. *Holsteins.* Average weight of cows, 1,200 to 1,300 lbs.; 6 lbs. oats, 2 lbs. oil meal, 3 lbs. bran, 35 lbs. ensilage, 10 lbs. timothy and clover hay, 8 lbs. oat and barley straw, 30 lbs. mangels and turnips. Bran is scalded and fed as slop.

The straw has probably been over-estimated, as the ration is high in organic matter and carbohydrates. A less quantity of straw would also tend to balance the ration. Making this allowance, the ration looks like a very good one.

10. *Grade Ayrshires.* Average weight of cows, 900 lbs.; 2 lbs. linseed meal, 5 lbs. bran, 3 lbs. mixed peas, oats and corn, 15 lbs. clover hay, 10 lbs. corn fodder, and 20 lbs. mangels or carrots.

11. *Grade Holsteins.* Average weight of cows, 1,100 lbs.; 8 lbs. oats, 40 lbs. ensilage, and about 10 lbs. straw.

No. 11*a*. Low in all constituents, especially protein. The protein could not be materially increased by feeding more straw, though the organic matter and carbohydrates could thus be made satisfactory. No. 11*b* shows the same ration with 3 lbs. old-process oil meal added. The improvement will be noted.

12. *Holsteins.* Average weight of cows, 1000 lbs.; 5 to 6 lbs. bran, 2 to 3 lbs. corn meal, 40 to 50 lbs. ensilage, 10 lbs. corn fodder, 5 lbs. timothy hay. Sometimes same quantity pea meal substituted for corn meal.

By referring back to Ration No. 12, as given in the report, it will be seen that 3 lbs. pea meal is sometimes fed in place of 3 lbs. corn meal. No. 12*a* represents ration with corn meal, and No. 12*b* with pea meal. The pea meal has made the ration better balanced, though it is still deficient in protein.

13. *Holsteins.* Average weight of cows, 1,200 lbs.; 8 lbs. oats, 2 lbs. bran, 40 lbs. ensilage, 10 lbs. straw, and 6 lbs. hay. Sometimes a little oil meal is fed, but meal ration never exceeds 10 lbs.

The main fault of this ration is that it is too low in protein. If the oil meal mentioned is fed in place of part of the oats, it will make an improvement.

14. *Jerseys.* Average weight of cows, 800 lbs.; 12 lbs. equal parts oats, bran and corn meal, 1 lb. oil meal, 20 lbs. corn fodder, 5 lbs. hay, 24 lbs. roots with straw *ad lib.*

Abnormally high in organic matter and carbohydrates. It is quite probable that the rough fodders have been over-estimated. Reducing the corn fodder would balance the ration very well.

15. *Holsteins.* Average weight of cows, 1,200 lbs.; 4 lbs. oats, 3 lbs. peas, 3 lbs. bran, 40 lbs. ensilage, 5 lbs. hay, and 10 lbs. straw. Sometimes 1 or 2 lbs. oil meal.

Very low in protein. The addition of the oil meal mentioned would improve the ration.

16. *Ayrshires and Jersey grades.* Average weight of cows, 800 lbs.; 2 lbs. bran, $^4/_5$ lb. oats, $^4/_5$ lb. barley, $^2/_5$ lb. peas, ½ lb. oil cake, 25 lbs. ensilage, 6 lbs. mangels, 1 oat sheaf between two cows, with straw *ad lib.*

17. *Jerseys.* Average weight of cows, 850 lbs.; 8 lbs. bran, 1½ lbs. oil meal, 40 lbs. ensilage, and 7 to 10 lbs. hay.

Rather high in organic matter and carbohydrates, though it may be called a fairly well-balanced ration. The weight of rough fodders has likely been over-estimated.

18. *Jerseys.* Average weight of cows, 900 lbs.; 5 lbs. corn meal, 5 lbs. oats, 5 lbs. oil meal, 20 lbs. corn fodder, 5 lbs. roots, 5 lbs. hay, and about 5 lbs. straw.

No. 18*a*. represents the ration as given in the report, and it will be noticed that it is abnormally high in all its constituents. This indicates that there must be some mistake in describing the ration, and therefore it was calculated again, with 20 lbs. ensilage instead of 20 lbs. corn fodder, and numbered 18*b*. The change has made an improvement, though it is still very high in protein and fat, which would indicate an expensive ration.

19. *Grade Ayrshires.* 3½ lbs. shorts, 1½ lbs. oil meal, 30 lbs. ensilage, 4 lbs. hay, 5 lbs. straw.

Very low in all constituents except fat, which indicates that quantities of fodder have been under-estimated.

20. *Ayrshires.* Average weight of cows, 800 lbs.; 2 lbs. oats, 2 lbs. peas, 2 lbs. shorts or bran, 2 lbs. oil meal, 12 lbs. clover hay, 1 peck roots, with straw *ad lib.*

In calculating this ration the straw has not been taken into account, which renders the nutritive ratio very narrow. The most marked feature of the ration is the large amount of protein, which indicates an expensive ration.

21. *Grade Shorthorns.* Average weight of cows, 900 lbs.; 7 lbs. mixed oats, peas, goose wheat and bran, in following proportions by measure: 3, 1, ½, 2¼; 40 lbs. ensilage, 5 lbs. clover hay, with straw *ad lib.*

22. *Ayrshires and Ayrshire grades.* Average weight of cows, 1,000 lbs.; 8 lbs. of corn, oats and bran, mixed in proportion of 10, 4 and 5, by weight, ½ bushel of roots, ½ bushel corn fodder, some oat hay, with straw *ad lib.*

23. *Ayrshires.* Average weight of cows, 950 lbs.; 3 lbs. oats, 3 lbs. barley, 3 lbs. peas, 8 lbs. corn fodder, 8 lbs. chaff, 5 lbs. straw, and 20 lbs. roots.

Low in protein. If bran were substituted for barley it would make an improvement.

24. *Holsteins.* Average weight of cows, 1,200 lbs.; 6 lbs. peas, 40 lbs. ensilage, 15 lbs. corn fodder, 15 lbs. chaff, 10 lbs. hay, 60 lbs. roots, with straw *ad lib.*

25. *Holsteins.* Average weight of cows, 1,100 lbs.; 4 lbs. corn meal, 4 lbs. bran, 1 lb. barley, 10 lbs. hay, and 20 lbs. straw.

Extremely low in protein, and high in carbohydrates and organic matter. Corn and barley are both low in protein.

26. *Grade Shorthorns.* Average weight in cows, 1,100 lbs.; 6 lbs. corn meal, 3 lbs. bran, 5 lbs. hay, with corn fodder *ad lib.* Corn fodder is steeped in hot water.

27. *Grade Shorthorns.* Average weight of cows, 1,050 lbs.; 5 lbs. bran, 45 lbs. roots, 50 lbs. corn fodder and chaff, and straw *ad lib.*

28. *Grade Shorthorns.* Average weight of cows, 1,200 lbs.; 6 lbs. equal parts oats, peas, bran and oil meal, 35 to 40 lbs. ensilage, 10 lbs. roots, with chaff and straw *ad lib.*

29. *Grade Shorthorns.* Average weight of cows, 1,100 lbs.; 9 lbs. oats, 3 lbs. peas, 20 lbs. hay, 60 lbs. roots, with straw *ad lib.*

30. *Grade Ayrshires, Holsteins and Natives.* Average weight of cows, 900 lbs.; 6 lbs. oats, 2 lbs. shorts, 1 lb. bran, 12 lbs. corn fodder, 15 lbs. straw, and 25 lbs. roots.

31. *Ayrshires and Ayrshire grades.* Average weight of cows, 800 to 1,200 lbs.; 5 lbs. bran, 5 lbs. peas, 35 to 45 lbs. ensilage, 10 lbs. timothy hay. Ration is regulated to suit capacity of cows.

Apparently a very well-balanced ration.

32. *Shorthorns and grades.* Average weight of cows, 1,150 lbs.; 3½ lbs. oats, 3½ lbs. peas, 24 lbs. ensilage, 4 lbs. hay, 10 lbs. straw, 25 lbs. roots.

Very low in protein. The addition of a few pounds of bran would improve the ration.

33. *Ayrshire and Shorthorn grades.* Average weight of cows, 1,000 lbs.; 10 lbs. mixed oats and corn in proportion of 3 to 1, 10 lbs. chaff, 5 lbs. hay, 15 lbs. potatoes, with straw *ad lib.* Would rather feed oats and peas in proportion of 3 to 2.

34. *Mixed breeds.* Average weight of cows, 1,000 to 1,200 lbs.; 15 lbs. equal parts oats and peas, ½ lb. flax seed, 35 lbs. roots, some corn fodder and hay, with chaff and straw *ad lib.*

35. *Grade Shorthorns, Holsteins, and Jerseys.* 4 lbs. bran, 1 lb. oil meal, 40 to 50 lbs. ensilage, 4 to 5 lbs. straw. Some potatoes and clover hay fed in spring.

Low in all constituents except fat. Cows probably eat more straw than is estimated, but this would not sufficiently increase the protein. The need of more bran or oil meal is indicated.

36. *Grade Jerseys and Holsteins.* Average weight of cows, 900 lbs.; 5 lbs. bran, 2 lbs. oil meal, 50 lbs. ensilage, 10 lbs. hay.

A very well-balanced ration. It has been calculated for timothy hay, but if clover hay is fed the ration would be still better balanced.

37. *Guernseys and Grades.* Average weight of cows, 1,000 lbs. 9 lbs. bran and shorts as it comes from the mill, 3 lbs. corn meal, 10 lbs. clover hay, and 45 lbs. roots.

A well-balanced ration, indeed. The 9 lbs. mixed bran and shorts have beer calculated as shorts, but this makes very little difference.

38. *Grades.* Average weight of cows, 800 lbs.; 8 lbs. equal parts bran and oats, 40 lbs. ensilage, 6 lbs. hay, and 6 lbs. roots.

39. *Grade Shorthorns.* Average weight of cows, 1,000 lbs.; 4 lbs. peas, 4 lbs. bran, 2 lbs. oil meal, 40 lbs. ensilage, 5 lbs. hay, and 5 lbs. straw.

Also an exceptionally well-balanced ration.

40. *Ayrshires.* 3 lbs. flax seed, 3 lbs. shorts, some roots, with hay *ad lib.*

41. *Various Grades.* Average weight of cows, 900 lbs.; 7 lbs. oats and corn and cob meal, mixed in proportion of 1 to 3, 50 lbs. ensilage, 5 lbs. corn fodder, 10 lbs. hay, 5 lbs. chaff, and 10 lbs. straw.

42. *Grade Aberdeen-Angus.* Average weight of cows, 1,000 lbs.; 3 lbs. oats, 1 lb. buckwheat, 1 lb. peas or barley, 10 lbs. hay, 1 bushel corn fodder, 20 lbs. roots, with straw *ad lib.*

43. *Grade Natives.* Average weight of cows, 1,000 lbs.; 8 quarts oats, with corn fodder, hay, turnips, and mangels.

44. *Natives.* Average weight of cows, 1,000 lbs.; 2 lbs. bran, 8 lbs. corn refuse from starch factory, 40 lbs. ensilage, 8 lbs. clover hay, 8 lbs. oat straw, and 20 lbs. roots.

45. *Ayrshires, Jerseys, Holsteins, and Grades of each.* Not more than 10 lbs. meal per cow, unless she gives over 50 lbs. milk per day, and in no case more than 15 lbs. meal. Meal preferred: oil meal, cracked oats, cotton-seed meal, bran, and malt combings, mixed in proportions, 1/10, 1/5, 1/5, 2/5, and 1/10,

but good results obtained without cotton-seed meal and malt combings. Also feed ensilage and straw, with 6 to 9 lbs. hay.

46. *Grade Shorthorns.* Average weight of cows, 1,100 lbs.; 2 lbs. peas, 2 lbs. oats, 2 lbs. wheat, 2 lbs. bran, 30 to 40 lbs. ensilage, 5 lbs. hay, 15 lbs. turnips, with chaff and straw *ad lib.* Heavier meal ration to some cows.

Too low in protein and high in carbohydrates. Could be made better balanced by increasing the amount of peas and bran. It has been assumed that cows eat 10 lbs. straw, which is probably too high an estimate.

47. *Various crosses.* Average weight of cows, 1,150 lbs.; 8 lbs. equal parts oats, peas and bran, with a little oil meal, 4 lbs. chaff, 8 lbs. straw, and 40 lbs., roots, turnips, mangels and potatoes.

48 *Grade Jerseys.* Average weight of cows, 900 lbs.; 16 quarts oats, ½ pint of meal, with straw and corn fodder *ad lib.*

49. *Grade Shorthorns.* Average weight of cows, 1,200 lbs.; 6 lbs. bran, 4 lbs. corn meal, 36 lbs. ensilage, 10 to 12 lbs. hay, ½ bushel beets.

Rather low in protein. This could be remedied by increasing the amount of oil meal or by adding bran.

50. *Jerseys and Grade Jerseys.* Weight of cows, from 700 to 1,000 lbs.; 9 lbs. oats, 48 lbs. ensilage, 8 lbs. timothy hay, 14 lbs. roots, with straw *ad lib.*

Low in protein. Substituting some bran or oil meal for part of the oats would increase the protein.

51. *Jerseys and Ayrshires.* Average weight of cows, 900 lbs.; 3 lbs. peas, 3 lbs. bran, 2 lbs. cotton-seed meal, 40 lbs. ensilage, 10 lbs. clover hay, with straw *ad lib.* Sometimes oatmeal is substituted for bran.

Very high in protein, which indicates an expensive ration. In calculating ration, no allowance was made for straw, which makes the nutritive ratio narrower than it would otherwise be.

52. *Ayrshires and Holstein Grades.* Average weight of cows, 800 lbs.; 4 lbs. oats, 2 lbs. bran, 45 lbs. ensilage, 10 lbs. timothy and clover hay.

53. *Shorthorns.* 5 lbs. barley, oats, and peas, in proportion of 2. 1, and 1 by weight, 7 lbs. corn fodder, 5 lbs. hay, 10 lbs. straw, and 30 lbs. roots.

54. *Ayrshires, Holsteins, and Jerseys.* 5 lbs. oats, 1 lb. flax seed, 40 lbs. ensilage, 15 lbs. straw, 30 lbs. turnips.

55. *Cross-bred Jerseys, Ayrshires, and Holsteins.* Average weight of cows, 1,000 lbs.; 10 lbs. equal parts barley and buckwheat, 40 lbs. ensilage, 10 lbs. straw, 5 lbs. roots.

56. *Ayrshires, Grade Ayrshires, and Shorthorns.* Average weight of cows, 1.150 lbs.; 2 lbs. oil meal, 4 lbs. bran, 40 to 50 lbs. roots, 15 to 20 lbs. ensilage, 10 lbs. hay, 10 lbs. straw.

57. *Grade Ayrshires.* 4 quarts oats, barley, and peas, 4 quarts bran, 1 handful of flax seed, 2 bushels ensilage, ½ bushel roots, some hay, with corn fodder *ad lib.*

58. *Grade Jerseys.* Average weight of cows, 800 lbs.; 18 lbs. mixed oats and corn and cob meal, 40 lbs. ensilage, 10 lbs. straw.

59. *Ayrshires.* Weight of cows, 800 to 1,000 lbs.; 5 lbs. oats or bran, 2 lbs. oil meal, 50 lbs. ensilage, 8 lbs. clover hay.

60. *Grades.* Average weight of cows, 1,100 lbs.; 6 lbs. oats, 6 lbs. flax seed, 20 lbs. corn fodder, 20 lbs. straw, 20 lbs. roots.

61. *Grade Shorthorns.* Average weight of cows, 1,150 lbs. 2 lbs. bran, 7 lbs. equal parts by measure of corn and oats, 24 lbs. ensilage, 12 lbs. corn fodder, 6 lbs. straw.

62. *Holsteins.* Average weight of cows, 1,300 lbs.; 1 lb. flax seed, 2 gallons equal parts peas, oats, barley, and bran, 30 lbs. corn fodder, 10 lbs. hay, 12 lbs. straw, 30 lbs. roots.

63. *Grade Shorthorns.* Average weight of cows, 1,000 lbs.; 6 lbs. corn, ½ lb. barley, ½ lb. bran, ½ lb. oil meal, 8 lbs. sugar beets or carrots, 2 bushels corn fodder, with straw *ad lib.*

64. *Grade Holsteins.* Average weight of cows, 1,100 lbs.; 5½ lbs. oats, 1 lb. oil meal, 21 lbs. timothy and Hungarian hay, 8 lbs. oat and barley straw, 17 lbs. turnips.

65. *Holsteins.* 7 lbs. equal parts oats, corn and peas, 52 lbs. of mixture made up of equal parts hay, pea straw and other straw, cut and mixed with ensilage in proportion of 4 to 5, 20 lbs. roots.

66. *Grade Ayrshires.* Average weight of cows, 750 lbs.; 4 to 6 lbs. bran and oil meal in proportion of 5 to 2 by weight, 35 lbs. ensilage, 5 lbs. hay, 4 lbs. straw.

67. *Ayrshires.* Average weight of cows, 1,000 lbs.; 6 lbs. mixed black barley, peas, and oats, 40 lbs. ensilage, 6 lbs. hay, 25 lbs. roots, with some straw.

68. *Grade Shorthorns and Holsteins.* Weight of cows, 1,100 to 1,200 lbs.; 4 lbs. bran, 4 lbs. oats, 2 lbs. barley, 50 lbs. ensilage, with oat straw *ad lib.*

69. *Cross-bred Ayrshires and Shorthorns.* Average weight of cows, 800 lbs.; 8 to 10 lbs. equal parts, by measure, of peas and oats, mixed with equal weight of bran, 20 lbs. ensilage, 15 lbs. turnips, 2 bushels chaff, with straw *ad lib.*

70. *Ayrshires.* Average weight of cows, 850 lbs.; 2 lbs. oil meal, 5 lbs. mixed oats and barley, 15 lbs. hay, 5 lbs. chaff, 4 lbs. straw, 15 lbs. roots.

71. *Grade Shorthorns.* Average weight of cows, 1,100 lbs.; 7 lbs. bran, 3 lbs. mixed oats and peas, 35 lbs. ensilage, 3 lbs. chaff, 6 lbs. straw, 15 lbs. roots.

72. *Shorthorn Grades.* Average weight of cows, 1,100 lbs.; 10 lbs. oats, 3 lbs. peas, 25 lbs. corn fodder, 30 lbs. mangels, with straw *ad lib.*

A fairly well-balanced ration, though containing a large amount of meal.

73. *Shosthorns.* Average weight of cows, 1,200 lbs.; 12 quarts equal parts bran and oats, with all they can eat of cut corn fodder, $^1/_3$; straw, $^2/_3$.

74. *Grade Shorthorns.* Weight of cows, 1,000 to 1,200 lbs.; 6 to 10 lbs. equal parts, by weight, of peas, oats and barley, 30 lbs. ensilage, 3 lbs. timothy hay, 14 lbs. straw, 10 to 12 lbs. mangels.

75. *Grade Jerseys.* Weight of cows, 800 to 900 lbs.; a mixture of cut corn stalks, with ears on, and cut sheaf oats and barley, all the cows can eat, with one feed clover hay and $^1/_3$ bushel mangels.

DISCUSSION OF SOME RATIONS FURNISHED IN REPORT.

For the purpose of comparing some of the rations used by Ontario dairymen with the German and American standards, a few of the more definite ones have been selected, and their digestible nutrients ascertained. Too much importance must not be attached to the composition of these rations, since, in some cases, the quantities of feed given are simply approximations. However, the rations are sufficiently definite to be of interest and value to the careful student.

For convenience of reference. the German and American standard rations for dairy cows are placed at the head of the list. It must be borne in mind that these standards present the amounts of organic matter and of digestible nutrients required per 1,000 lbs. live weight of the animal, and that the term "total organic matter" means the total amount of dry matter furnished in the ration, including both the digestible and indigestible constituents of the food.

The constituents of the rations analysed below have all been calculated per 1,000 lbs. live weight of cows, and the number opposite each ration corresponds with its number in the report, so that it can readily be referred to.

TABLE SHOWING CONSTITUENTS OF SOME ONTARIO RATIONS FOR DAIRY COWS.

Number of Ration	Total Organic matter.	Digestible matter.				Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
German standard	24.00	2.50	12.50	.40	15.40	1: 5.4
American standard	24.51	2.15	13.27	.74	16.16	1: 6.9
No. 1	25.47	2.27	12.83	.81	15.91	1: 6.4
„ 2	29.80	2.07	15.12	.32	17.31	1: 7.6
„ 5	27.64	2.34	19.20	.71	22.25	1: 8.8
„ 6	21.21	1.90	11.00	.84	13.74	1: 6.6
„ 8	32.19	1.90	17.68	1.06	20.64	1:10.5
„ 9	27.52	2.04	14.72	.73	17.49	1: 8.0
„ 11a	22.30	1.13	11.58	.60	13.31	1:11.4
„ 11b	25.01	1.99	12.56	.81	15.36	1: 7.2
„ 12a	26.46	1.69	14.71	.73	17.13	1: 9.7
„ 12b	26.47	1.96	14.26	.62	16.84	1: 8.0
„ 13	26.35	1.50	13.16	.65	15.31	1: 9.7
„ 14	29.84	2.29	17.05	.85	20.19	1: 8.3
„ 15	25.56	1.56	13.15	.56	15.27	1: 9.2
„ 17	28.31	2.25	14.30	.74	17.29	1: 7.5
„ 18a	29.82	3.30	18.41	1.20	22.91	1: 6.4
„ 18b	24.93	2.95	13.58	1.06	17.59	1: 5.4
„ 19	18.52	1.31	9.60	.45	11.36	1: 8.1
„ 20	23.42	2.77	11.12	.66	14.55	1: 4.5
„ 23	28.17	1.65	15.15	.41	17.21	1: 9.7
„ 25	31.57	1.35	16.05	.42	17.82	1:12.6
, 31	25.94	2.07	13.73	.57	16.37	1: 6.7
„ 32	23.99	1.45	12.70	.44	14.59	1: 9.4
„ 35	19.43	1.27	9.95	.54	11.76	1: 8.8
„ 36	28.18	2.10	14.42	.85	17.37	1: 7.7
„ 37	24.83	2.40	13.26	.69	16.35	1: 6.1
„ 39	26.17	2.29	13.36	.65	16.30	1: 6.4
„ 46	28.00	1.60	15.05	.55	17.20	1:10.1
„ 49	25.55	1.76	14.25	.63	15.88	1: 8.9
„ 50	26.54	1.59	14.39	.82	16.80	1:10.2
„ 51	26.66	2.88	11.52	.86	15.26	1: 4.7
„ 72	26.14	2.13	14.92	.68	17.73	1: 7.7

No standard of feeding can be blindly followed, and it may be quite possible that some of the suggestions offered above will prove impracticable for the dairyman using the ration. A farmer must make the best possible use of the fodders at his disposal, and he may sometimes find that it pays him better to use a comparatively poorly-balanced ration, rather than sell the grain he has on hand in order to purchase fodders with which to form a balanced ration. The suggestions and criticisms, therefore, may be taken for what they are worth, as they are intended merely as helps to those who may decide to copy any of the rations mentioned. Considerable variety is offered, and a study of the table, in connection with the study of the rations represented therein, will be a help in making an intelligent selection.

Another very important point must not be overlooked. Feeding is only one side of the question, and, though it may do much, it cannot do all. The value returned for the food consumed depends upon the cow, and a good cow fed upon a poorly-balanced ration will do better for her owner than a poor cow fed in the most scientific manner. Feeding, breeding and weeding are inseparably connected in the successful maintenance and improvement of a dairy herd.

RATIONS FOR DAIRY COWS.

(From Wisconsin Bulletin 33.)

We are constantly receiving letters from farmers asking for advice in regard to the proper kinds of feeds for milch cows, and how to combine them so as to obtain first-class results.

The following daily ration may be considered a standard American ration for milch cows, in full flow of milk, weighing about 1,000 lbs. Being founded on practical American feeding experience, its adoption is recommended as a basis for calculation of rations for milch cows under our conditions in preference to Wolff's standard ration, now generally used.

Organic matter.	Digestible protein.	Digestible carbohydrates.	Digestible fat.	Total digestible matter.	Nutritive ratio.
lbs.	lbs.	lbs.	lbs.	lbs.	
25.6	2.2	13.3	.8	16.3	1:6.9

Applying our best knowledge on the subject to the conditions present in our State, we further believe that the following six rations are worthy of trial. It is presumed that they will meet the wants of our farmers, and that with the right kind of cows good results will follow their feeding. Of course, no practical dairyman can weigh out the several constituents of a ration each day for each animal in the herd. Let him use the scales in determining what certain measures hold, and use these for distributing the food among the members of the herd.

[illegible] 1.—Corn silage, 40 lbs.; clover hay, 8 lbs.; wheat bran, 6 lbs. cor[illegible]al, 3 lbs.

Total organic matter	24.44 lbs.
Digestible protein	2.01 „
Digestible carbohydrates	13.22 „
Digestible fat	.75 „
Total digestible matter	15.90 „

Nutritive ratio, 1 : 7.4.

RATION 2.—Fodder corn, 20 lbs.; hay, 6 lbs.; oats, 4 lbs.; shorts, 4 lbs.; oil meal, 2 lbs.

Total organic matter	25.60 lbs.
Digestible protein	2.10 „
Digestible carbohydrates	14.49 „
Digestible fat	.75 „
Total digestible matter	17.34 „

Nutritive ratio, 1 : 7.7.

RATION 3.—Corn silage, 50 lbs.; corn stalks (stover), 6 lbs.; oats, 6 lbs.; malt sprouts, 4 lbs.; corn meal, 2 lbs.

Total organic matter	25.81 lbs.
Digestible protein	2.12 „
Digestible carbohydrates	14.38 „
Digestible fat	.81 „
Total digestible matter	17.31 „

Nutritive ratio, 1 : 7.6.

RATION 4.—Clover silage, 30 lbs.; hay, 15 lbs.; wheat bran, 3 lbs.; corn meal, 3 lbs.; cotton-seed meal, 2 lbs.

Total organic matter	26.32 lbs.
Digestible protein	2.53 „
Digestible carbohydrates	12.97 „
Digestible fat	.77 „
Total digestible matter	16.27 „

Nutritive ratio, 1 : 5.8.

RATION 5.—Timothy hay, 10 lbs.; clover hay, 8 lbs.; wheat bran, 6 lbs.; oats, 6 lbs.

Total organic matter	24.62 lbs.
Digestible protein	2.13 „
Digestible carbohydrates	12.51 „
Digestible fat	.67 „
Total digestible matter	15.31 „

Nutritive ratio, 1 : 6.6.

RATION 6.—Fodder corn, 20 lbs.; clover hay, 8 lbs.; oats, 6 lbs.; oil meal, 3 lbs.

Total organic matter	27.35 lbs.
Digestible protein	2.40 „
Digestible carbohydrates	14.12 „
Digestible fat	.85 „
Total digestible matter	17.37 „

Nutritive ratio, 1 : 7.0.

The results given in the preceding pages teach us emphatically that heavy feeding pays. A cow producing a full flow of milk should receive over 70 per cent. more food than is required for the maintenance of her body; it is the excess over maintenance that brings profit to the feeder.

The teachings of this bulletin may be briefly stated as follows:—

Keep only cows that respond to good feeding.

Feed liberally, but not to waste.

Select such feed stuffs as will supply a fair quantity of protein.

Raise and feed more oats and clover; use bran, shorts, and oil meal whenever needed, and when obtainable at a reasonable price.

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